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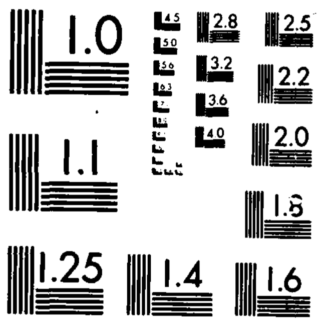
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AD-A165 265

PRELIMINARY DESIGN FOR DISPOSAL OF DREDGED MATERIAL FROM THIMBLE SHOAL CHANNEL ON EAST OCEAN VIEW BEACHES

NORFOLK, VIRGINIA

BY

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DTIC FILE COPY

FINAL REPORT

JULY 1984

Prepared for:
Dredging Management Branch
Norfolk District, Corps of Engineers
803 Front Street
Norfolk, Virginia 23510

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Report specifies that suitable fill for East Ocean View beaches can be obtained from Thimble Shoal Channel deepening to -55 feet. Along 6000 feet of eroded shore just west of Little Creek Entrance, preliminary design computations indicate that a uniformly thick placement totaling 333,000 cubic yards can be accomodated. Placement must be designed to minimize occasional eastward transport.

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EXECUTIVE SUMMARY

Suitable fill for East Ocean View beaches can be obtained from Thimble Shoal Channel, if the Main Channel is deepened to -55 feet MLW. The designated dredging area within the eastern half of the channel is 3 miles long and 500 feet wide, lying south of the centerline in the Main Channel and including the Chesapeake Bay Bridge-Tunnel crossing. Based on three cores of the area, there are 850,000 cubic yards of fine-to-medium quartz sand which require dredging above -55 feet MLW; up to 500,000 cubic yards were previously recommended for beach disposal on Willoughby Spit, but the remainder was not assigned to a suitable beach for disposal. This material matches well with native sands at East Ocean View shore roughly six miles away.

Along 6,000 feet of eroded East Ocean View shore just west of Little Creek Entrance, preliminary design computations indicate that a uniformly thick placement totaling 330,000 cubic yards can be accommodated. This should result in a shore advance of about 100 feet, almost the maximum advisable advance near the Entrance. The basic design profile includes a berm elevation of +6 MLW, an initial buildout distance of roughly 200 feet, and an equilibrium foreshore slope of 1 on 11. There should be only about 10% lost by rapid removal of fines from this dredged material, which is expected to last at least 13 years as a supply to downdrift beaches further west. Placement of the dredged material on the beach must be designed to minimize occasional eastward transport carrying littoral sands into the Entrance Channel.

The continuity and extent of the Thimble Shoal Channel sands need further delineation since the area to be dredged suitable for disposal at East Ocean View is very elongate and based on only three cores.

CONTENTS

Note: A large drawing of the "Beach Disposal Plan" for East Ocean View is provided separately from this report.

FIGURES

TABLES

PREFACE

This report summarizes engineering work performed to investigate the feasibility of using dredged material for beach fill on East Ocean View Beaches at Norfolk, Virginia. The potential source of dredged material would be sediments in Thimble Shoal Channel made available through planned harbor deepening. The benefits derived through such utilization of dredged material appear to be profound.

This study and related engineering work were performed under Contract No. DACW65-84-D-0054 by Waterway Surveys and Engineering, Ltd. (WS&E) for the Dredging Management Branch, Norfolk District, Corps of Engineers. The work was coordinated by Mr. Richard Klein, Project Engineer.

The firm of Cyril Galvin, Coastal Engineer performed as a consultant and participated in both field investigation and engineering analysis.

The report was prepared by Robert Hallermeier, Jonathan W. Lott, Cyril Galvin, and James W. Holton. The field work was carried out under the supervision of W.C. Holton, and technical engineering support was provided under the supervision of John Walsh.

INTRODUCTION

Extensive surface deposits of fine to medium quartz sand occur in the eastern half of Thimble Shoal Main Channel within lower Chesapeake Bay. In developing plans for deepening this channel, the possible usefulness of dredged material as fill on nearby beaches is one important consideration: it would be preferable to dispose of the material beneficially at a local site than to place it without benefit at a remote site.

The shore examined here is that of East Ocean View, Norfolk, Virginia, about four nautical miles south of the western part of Thimble Shoal Channel (Figure 1), and immediately west of the jettied and dredged Little Creek Entrance. East Ocean View beaches are fully exposed to waves from central Chesapeake Bay, and also subject to some wave action from the Atlantic Ocean.

Following sections in this report provide a summary of promising dredging sites in Thimble Shoal Channel; results of 1983 field investigations within the study area; a review of coastal processes near East Ocean View; and computations relating to design and execution of the beach disposal under consideration. Finally, the summary section emphasizes conclusions regarding feasibility of disposal and recommendations for advisable further investigations.

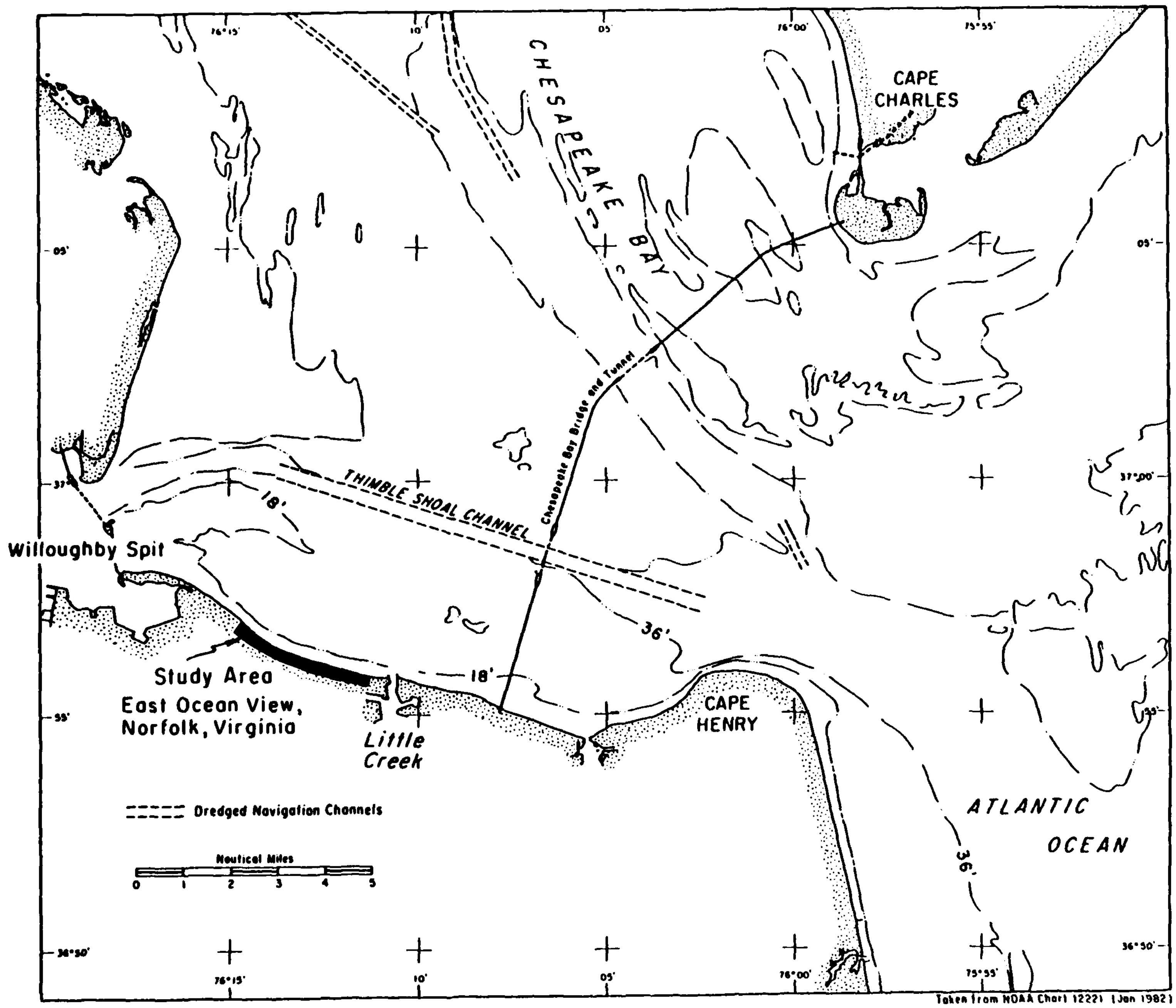

Figure 1. Chesapeake Bay Entrance with relevant sites and depth contours.

DREDGING AREAS FOR SAND IN THIMBLE SHOAL CHANNEL

Thimble Shoal Channel is presently 9.9 nautical miles long, with its eastern end at the naturally deep main entrance to Chesapeake Bay, just north of Cape Henry, and its western end at the naturally deep entrance to Hampton Roads, north of Ocean View, Norfolk, Virginia (Figure 1). The currently authorized project consists of a main channel 1000 feet wide with nominal water depth of 45 feet MLW, and flanking auxiliary channels each 450 feet wide with nominal water depth of 32 feet MLW.

During June 1983, vibratory bottom cores were obtained at 42 sites in Thimble Shoal Channel to identify existing nearsurface sediments. Analysis of these cores indicated two adjacent areas in the eastern half of the Main Channel with large sand volumes above -55 feet MLW. These are designated in Figure 2 as Dredging Areas Y and Z; Area Y is defined by three cores, and Area Z by six cores. Figure 3 displays composite grain-size distributions of material above -55 feet MLW in each of these areas. There are about 850,000 cubic yards of this material in Area Y and about 2,100,000 cubic yards in Area Z based on extrapolation of available cores. (The extrapolation used to estimate the volume in Area Y needs to be confirmed.) Previous reports have recommended that eroded Fort Story beaches be filled with 1,000,000 cubic yards of Area Z material (Hallermeier, et al., 1984a), and that eroded Willoughby Spit beaches be filled with at most 500,000 cubic yards of Area Y material (Hallermeier, et al., 1984b).

Potential dredging areas Y and Z are the only extensive areas with surface sands in Thimble Shoal Main Channel, according to available cores. Final selection of the more

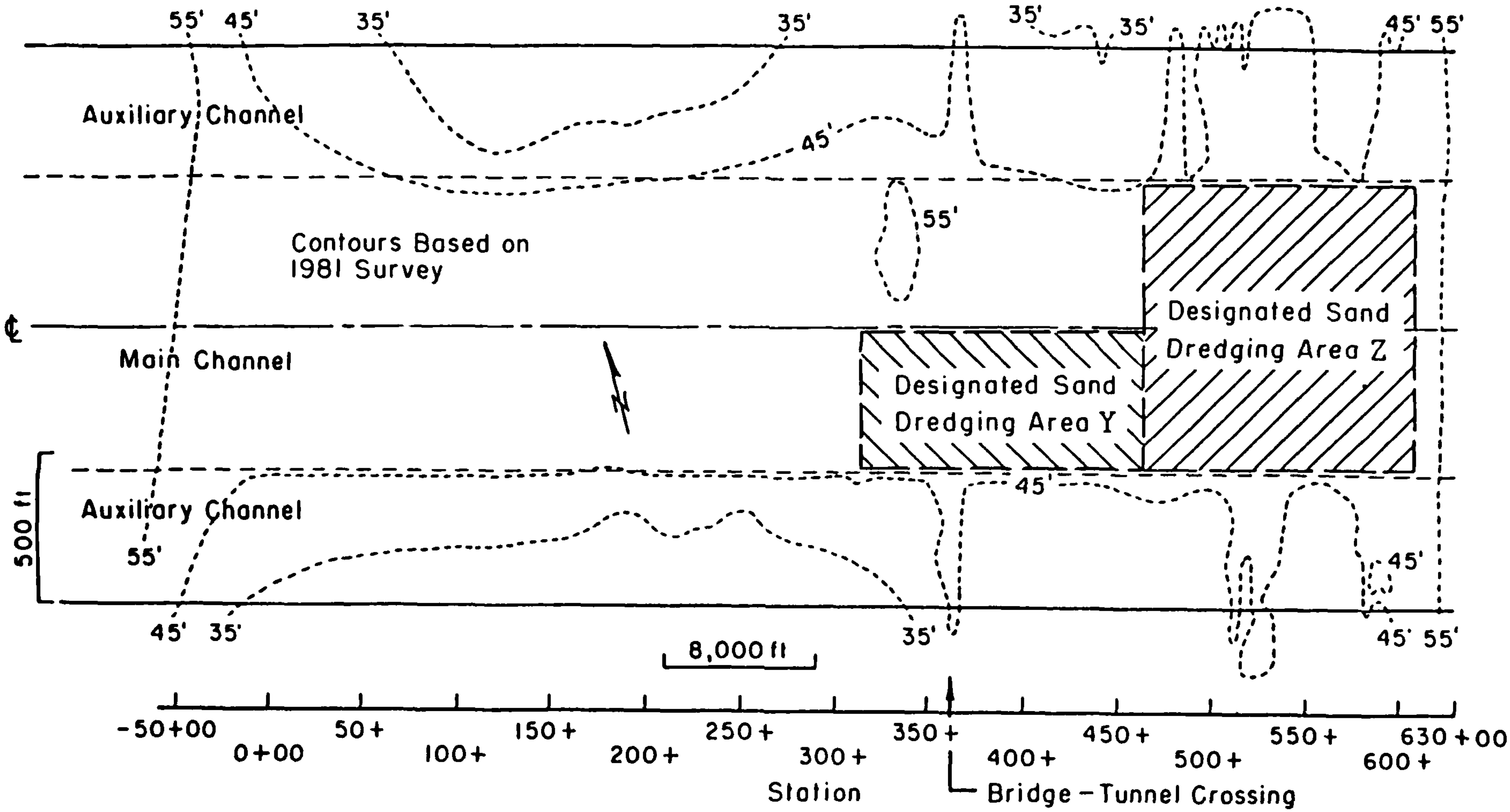

Figure 2. Designated sand dredging areas in eastern half of Thimble Shoal Channel. Cross-channel scale exaggerated 16 times.

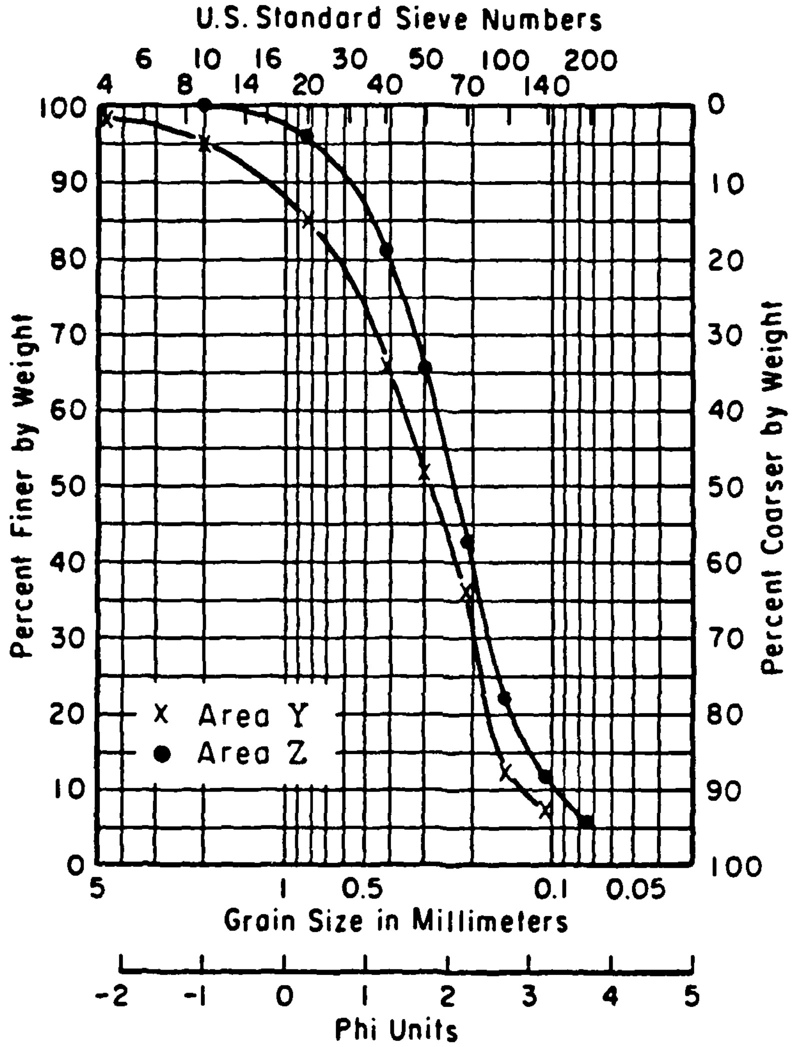

Figure 3. Composite grain-size distributions for the two dredging areas of Figure 2.

suitable dredged material for beach fill at East Ocean View depends on matches of size characteristics with native beach sediment. Another consideration is that Dredging Area Y is roughly three miles closer than Dredging Area Z to beaches in the present study area.

NEW FIELD INVESTIGATIONS OF EAST OCEAN VIEW

The shore under investigation extends for about 3 1/2 miles between Ocean View Pier on the west and Little Creek Entrance on the east, but does not reach to either of those features. Data collection during August 1983 consisted of sounding and sampling the bed on 8 shore-normal lines in East Ocean View. Each profile line ran for 2000 feet, from at least +10 feet MLW on the beach to seaward of -20 feet MLW. Sediment samples totaled 32, from five types of location along a profile line: dune, berm, foreshore, low-tide terrace, and offshore. (In addition, a drogue study of tidal currents was attempted in September 1983, but this provided no useful information.)

Figure 4 displays the hydrography determined by the 1983 survey, along with the locations of profile lines and offshore samples. The most prominent feature is the long nearshore bar indicated by the paired 5-foot isobaths present on all but profile line 1. The overall slope of this coastal area is noticeably steeper in the western end, where the 15- and 20-foot MLW isobaths are closer to shore. This survey reached -25 foot MLW only on line 2.

Figure 5 displays 8 profiles arranged in three groups. Each group is overlaid to intersect at the MLW shoreline. The nearshore bar is well defined in these profile views,

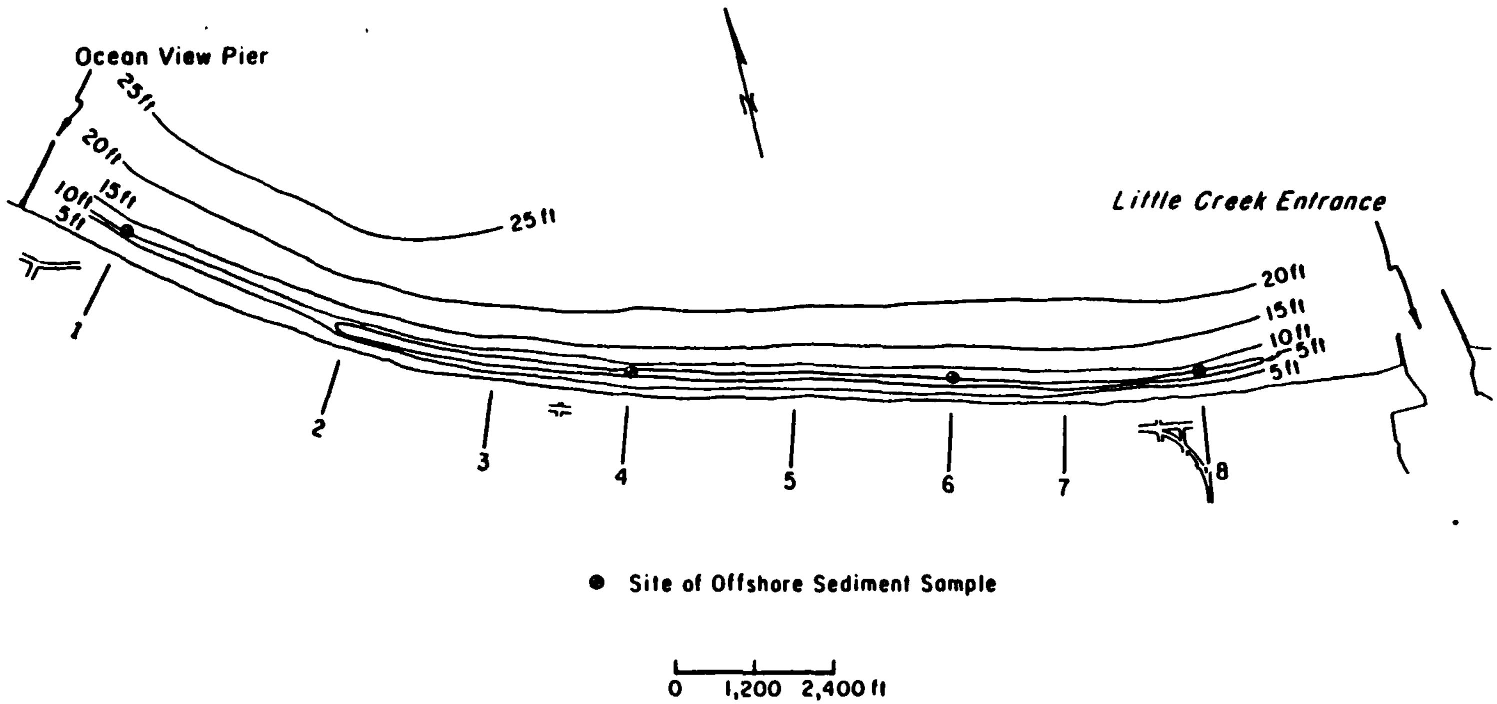

Figure 4. Location of profile lines and resultant water-depth contours (MLW) in August 1983 survey of East Ocean View.

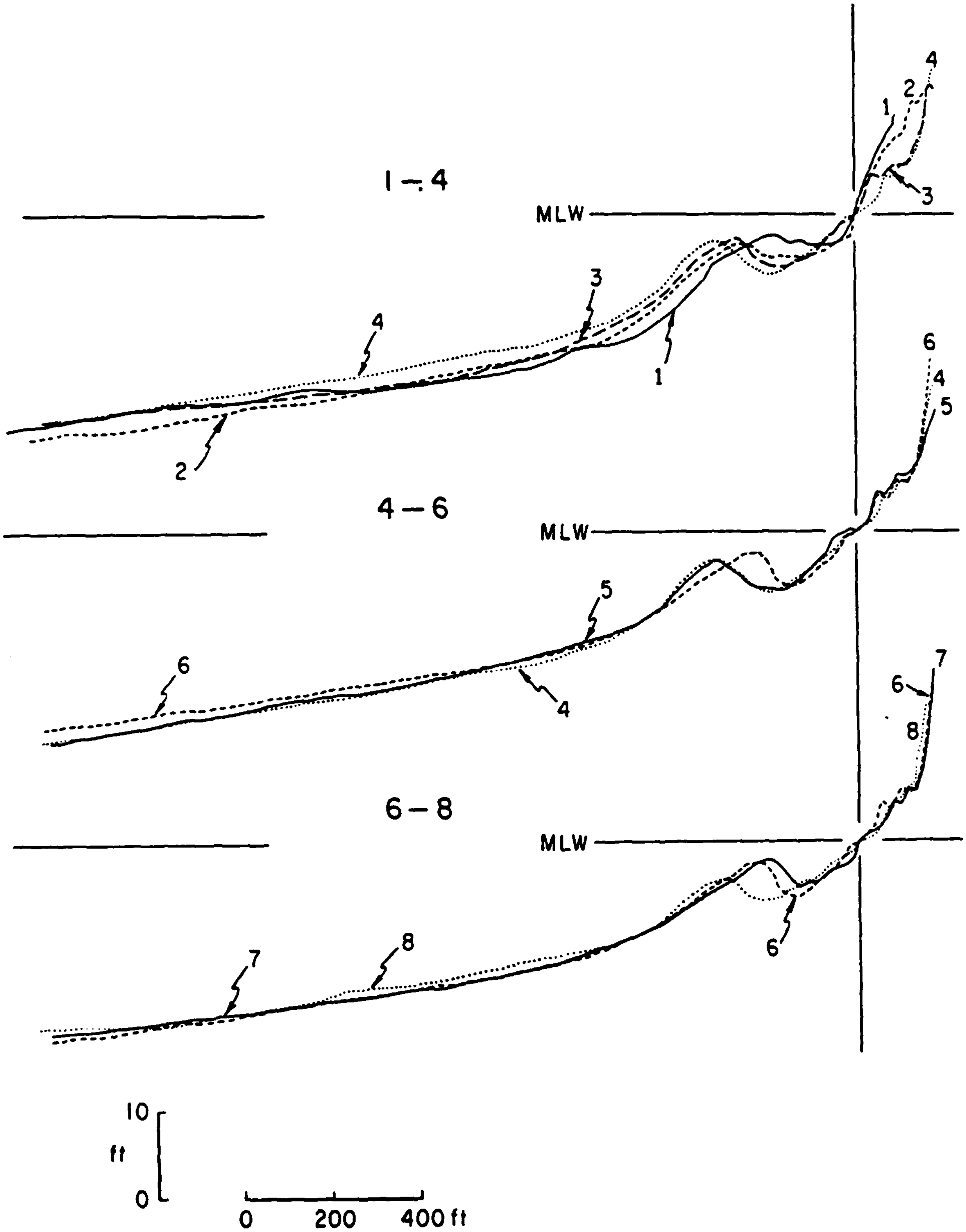

Figure 5. Beach and nearshore profiles at East Ocean View in August 1983.

and its alongshore variations are quite orderly. The bar moves further offshore and acquires a larger relief proceeding eastward between lines 1 through 4, and shows just the opposite behavior between lines 5 through 7. Bar geometry is nearly identical on line 4 and line 5, with the crest about 320 feet seaward of MLW shoreline, water depth of 3 feet MLW over the crest, and crest-to-trough relief of nearly 4 feet. Line 8 (closest to Little Creek entrance) does not fit into this alongshore pattern of bar behavior, perhaps because of the present erosion and sand supply problems towards this eastern end of the study area.

Beach geometry exhibits a simple longshore variation in Figure 5. Proceeding eastward from line 1, the beach becomes progressively wider, acquiring on line 3 a persistent double berm near +4 and +6 feet MLW. The feature becomes nearly imperceptible and the beach width decreases on line 8, indicating the eroded state there.

Sediment samples provide additional alongshore distinctions. Appendix A to this report contains plots showing alongshore variations of median and extreme grain diameters in sediment samples: D_{16}, D_{50} and D_{84} values from sieve analyses, grouped together by position on the profile. Between lines 3 through 8 inclusive, grain sizes are somewhat variable, but there is no clear trend alongshore and all sediments are fine-to-medium sands. However, sediments become noticeably coarser further west on lines 2 and 1; this size change exceeds one phi unit (i.e., a factor of 2 in grain diameter) and is most exaggerated in the gravel sampled offshore on line 1. The other striking aspect of sediment variability in this study area is that every offshore sediment is notably coarser and more poorly sorted than any other sample from the same profile line.

In addition to the August 1983 field investigations, East Ocean View beaches were photographed from the air on 23 May 1983, then inspected and photographed on 13 December 1983. Seasonal effects are not readily apparent from the photographs, but the basic impression from touring the beaches is consistent with data discussed above. The clear pattern is: slight erosion problems exist at the western end of the study area; central beaches, near lines 3 through 5, are wide with large dunes, exhibiting a very large reservoir of sand available for storm protection; and eroded beaches extend from the eastern end of the study area to the Little Creek Entrance, which has dual jetties.

In December 1983, dredging of Little Creek Entrance Channel was underway, with about 160,000 cubic yards of dredged material to be placed westward of the west (downdrift) jetty and the balance placed to the east of the east jetty; the size characteristics of that material are not known, so its potential for alleviating East Ocean View erosion cannot be assessed here. In addition, the City of Norfolk placed about 420,000 cubic yards of material dredged from Pretty Lake (western branch of Little Creek) on the Norfolk City Beach at East Ocean View, during Spring 1984.

COASTAL PROCESSES OF STUDY AREA

Local Environment. There is a wide range of available information regarding the marine environment close to the study area. Table 1 provides a summary of nearby sea measurements: water levels, tidal currents and wave characteristics. Local sea level rise has been relatively rapid

Table 1. Summary of basic marine environmental measurements for region near East Ocean View, Norfolk, Virginia.

A. Sea Level Trend (Hicks et al, 1983)

At Hampton Roads/Sewells Point: 36°56.8'N, 76°19.9'W
+4.3 mm/year (0.014 ft/year), 1928 through 1980
+3.6 mm/year (0.012 ft/year), 1940 through 1980

B. Tidal Characteristics (National Ocean Survey, 1982 a/b; NOS Chart 12256)

Shore Sites	Mean Level, ft MLW	Mean Range, ft	Spring Range, ft
Hampton Roads/ Sewells Point 36°57'N, 76°20'W	1.2	2.5	2.9
Little Creek Entrance	1.2	2.4	---
Little Creek RR Terminal 36°55'N, 76°11'W	1.3	2.6	3.1
Lynnhaven Inlet 36°54'N, 76°05'W	1.0	2.0	2.4

	Average Maximum Currents			
	Flood		Ebb	
Marine Sites	knots	degrees	knots	degrees
0.7 mile N of Willoughby Spit 36°58.8'N, 76°17.3'W	1.0	285	0.8	080
Little Creek: 0.5 mile N of West Jetty 36°56.32'N, 76°10.81'W	0.9	274	0.9	108
Little Creek: N of East Jetty 36°56.05'N, 76°10.6'N	0.9	280	1.0	076
Chesapeake Bay Bridge-Tunnel 1.5 miles N of shore 36°56.69'N, 76°07.33'N	0.8	305	0.9	100

C. Wave Climate (based on data in Thompson, 1977)

At South Thimble Island, Chesapeake Bay Bridge-Tunnel
36°58'N, 76'°07'W
April 1971 through August 1974

	Measured Wave Conditions:		
	Average	Median	Extreme
Height, ft:	1.62	1.35	7.6
Period, sec:	3.70	3.40	5.5

compared to other East Coast sites (Hicks, 1983). Expected waves are relatively short but can be fairly high for "extreme" conditions, defined as those high waves occurring 12 hours per year. Tides near the study site are semi-diurnal with moderate ranges and peak current velocities. It appears that flood and ebb flows are closely balanced, and tidal currents approximately paralleling the East Ocean View shore are not expected to have significant effects on coastal processes.

Figure 6 provides the 1981 wind rose for South Thimble Island of the Chesapeake Bay Bridge Tunnel, near Thimble Shoal Channel. This site is near the location of the wave gage whose data are summarized in Table 1C. Strong winds mostly have a component from the north, so that centered exposure northward to middle Chesapeake Bay should result in representative lower-Bay seas at that gage site. Whether measured waves are entirely typical of the south shore of Chesapeake Bay is another matter; the wave gage is about 5.5 nautical miles from the Bay Entrance, whereas East Ocean View is about 10 nautical miles, so that Atlantic Ocean waves are expected to be less appreciable at the study area than at the gage.

Computations. Here the primary application for available wave measurements is in estimating seaward limits to appreciable sand movements. The seaward limits considered here are those defined in Hallermeier (1981): a maximum water depth for surf effects, d_s, based on an extreme wave condition, and a maximum water depth for usual sand motion, d_m, based on median wave condition and sand diameter. Taking D_{50} = 0.13 mm for the fine gray sand common in lower Chesapeake Bay (Meisburger, 1972), Table 3 wave conditions from the Thimble Shoal Channel gage yield d_s = 13.3 feet and

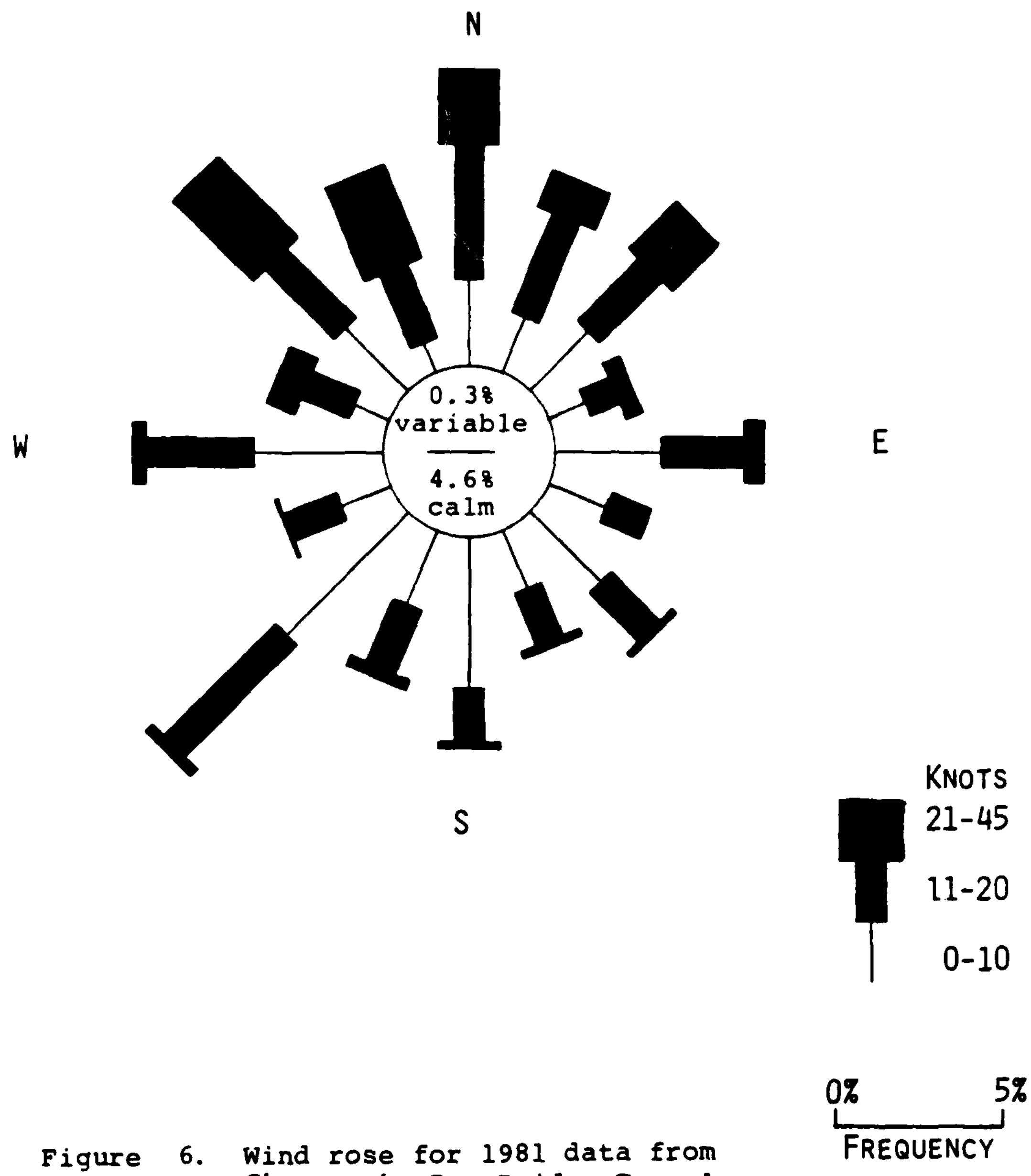

Figure 6. Wind rose for 1981 data from Chesapeake Bay Bridge-Tunnel (South Thimble Island)

d_m = 17.8 feet. Both water depths are with respect to MLW, and the numbers are to be rounded upwards to the nearest foot for engineering usage.

The pertinence of these computed values must be examined for the study area some 5 nautical miles WSW of the wave gage location. Appendix B documents investigations concerning Bay exposure of sites under consideration, with findings summarized as follows. At the gage site, effective fetch for Bay wave generation was determined to be about 29.4 nautical miles, with the central fetch radial near compass direction 355° and representative water depth of 35 feet MLW within the fetch. For profile line 8 at the east end of the study area, effective fetch was measured to be 29.7 nautical miles with central radial near 005° and typical water depths of about 36 feet. These Bay exposures are almost identical. The major fetch at the gage site is aligned 10° closer to the direction of strongest winds , but the potential fetch reduction of cos 10° = 0.985 at East Ocean View is balanced by the slightly larger geometry of that site's direct fetch. In fact, these fetch differences are too small to make any difference in using wave forecasting curves in the Shore Protection Manual.

Table 2 presents a few examples of Chesapeake Bay waves forecast for these approximate fetch dimensions, both with the median wind speed of 11 knots and with a representative extreme wind speed of 35 knots. Comparison with Table 1C confirms that computed wave heights and periods for the strong north wind correspond closely to measured storm waves. For the median wind speed, however, computed wave periods are appreciably less than those usually measured, indicating an appreciable admixture of low, long-period waves from the Atlantic Ocean occurs at the gage site. The

Table 2. Forecasts of wave conditions for lower Chesapeake Bay with north winds. Significant wave heights and periods are for fetch length of 29.5 nautical miles and constant water depth of 35 feet.

Wind Speed knots	Wave Height feet	Wave Period seconds
11 (shallow water curve)	1.9	2.9
11 (deep-water curve)	2.0	3.1
35 (shallow-water curve)	5.9	5.3

height of Atlantic waves must be somewhat less at the study area than at the gage, but Ocean waves in either instance appear secondary in importance compared to Bay waves.

With these minor differences in wave climate, slight adjustments seem appropriate in adapting limit depths at the wave gage site for use at East Ocean View. The depth d_m varies as height times period for usual waves, and the depth d_s varies as height of extreme waves. With these considerations, appropriate estimates are judged to be d_s = 13 feet MLW and d_m = 17 feet MLW for the study area.

Overview of Dominant Processes. Both previous studies and the present investigations suggest that Little Creek Entrance jetties may cause beach erosion at East Ocean View. Figure 7 displays charted hydrography near the rubble jetties. The dredged channel is about 400 feet wide by 22 feet deep at MLW. (Project depth has recently been 21 feet MLW, and 1983 chart 12222 gives the controlling depth as 19.5 feet.) The east jetty extends approximately 1000 feet from shore, roughly the distance to the 15-foot MLW contour in the vicinity. The west jetty extends approximately 750 feet from shore, roughly to the 12-foot-MLW contour.

Indications are that the engineering improvements to Little Creek Entrance may prevent appreciable bypassing of littoral drift. As a summary of previous studies, Fleischer, McRee, and Brady (1977) concluded (p. 23)

> "... that littoral transport is interrupted, probably almost entirely, at Little Creek and that bypassing by tidal currents around the jetties and the channel is minimal. The bathymetry at the

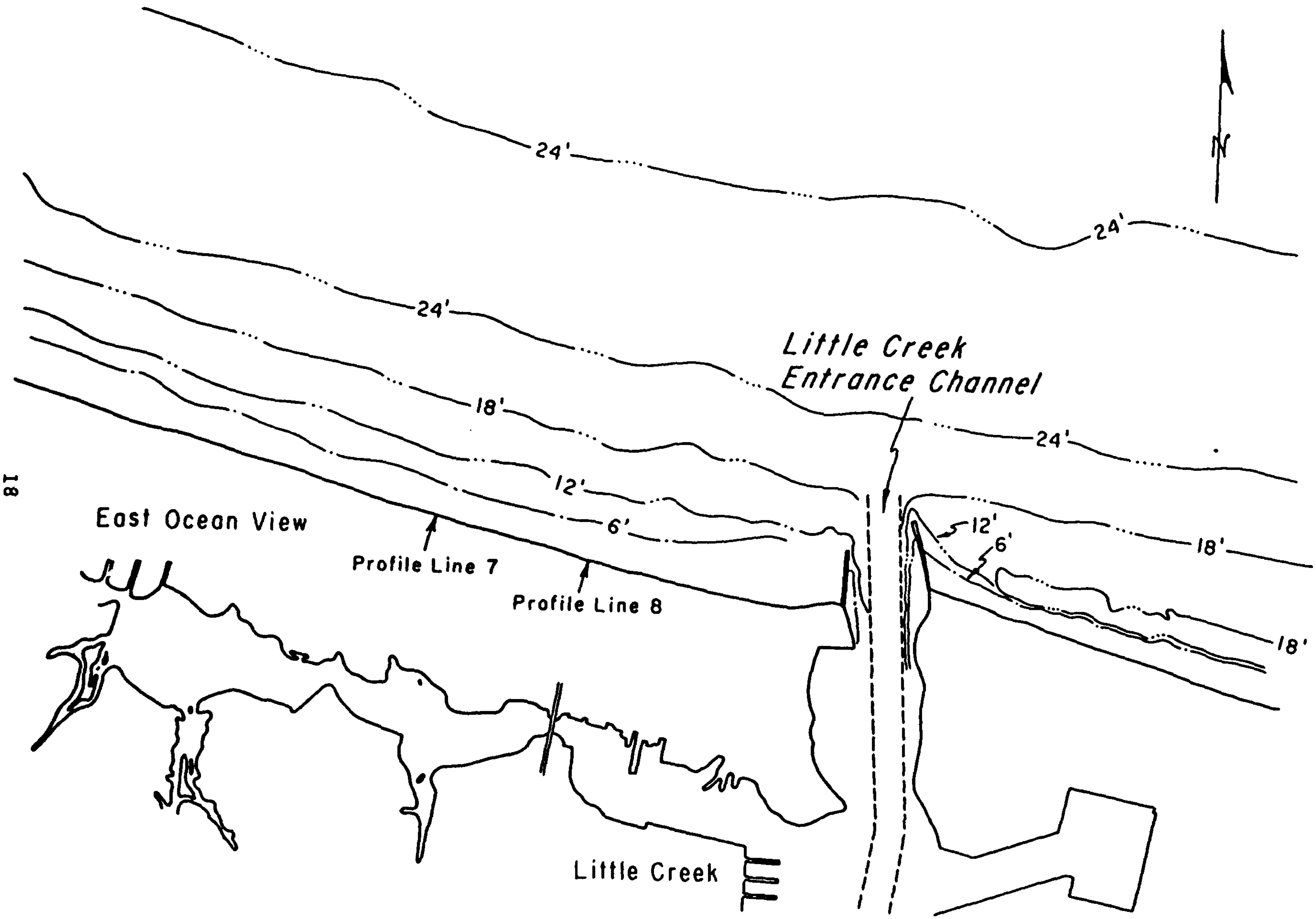

Figure 7. Charted hydrography near Little Creek Entrance (NOS Chart 12256; June 1982).

> jetties also indicates that bypassing is unlikely.... When the sand [moving westward] reaches the end of the [east] jetty, it is in water too deep for effective littoral transport, and is deposited in the channel or dispersed by tidal currents outside the channel."

These statements about littoral transport seem entirely consistent with the value of d_s = 13 feet MLW, presented above as the seaward limit to surf effects and littoral sand transport. Also, inactivity of sand once deposited at the seaward end of the dredged channel is fully compatible with d_m = 17 feet MLW as the usual limit to sand motion by waves. On a related topic, May 1983 aerial photographs indicate that beach sand passes over or through the east jetty into Little Creek Entrance, where shelter from wave action implies bottom sands should be quite inactive. Finally, in regard to the capacity of local tidal currents to transport sand, Table 1B shows that near Little Creek Entrance there is a very slight tendency toward ebb dominance by tidal currents. This means that net tidal flow is (slightly) eastward, or opposite the net westward longshore transport.

Fleischer, et al. (1977) analyzed quantitative long-term effects of littoral barriers at Little Creek Entrance on the beaches at the eastern end of the present study area. Shoreline changes between 1958 and 1974 along 6000 feet of coast immediately west of the west jetty show a total shore loss of 510,000 square feet over the 16 years. These values were converted to an estimate of 32,000 cubic yards per year for the net rate of sand loss in this region, by means of the rough equivalence between one square foot of beach area change and one cubic yard of nearshore sand volume change. (SPM, pp. 4-120, 4-122). However, that rule of thumb is

appropriate only on fully exposed sea coasts, because it presumes sand movement over a total elevation range of 27 feet, about from a seaward limit at -18 feet MLW to a landward limit at +9 feet MLW. For East Ocean View, proper limits appear to be -13 feet MLW (d_s) to +6 feet MLW (upper berm elevation), so that the vertical range to activity is 19 feet and the equivalence should be 1 square foot of beach change = 19 cubic feet of volume change at this site. Thus, the observed rate of shore loss more correctly corresponds to 22,500 cubic yards per year of net nearshore erosion at East Ocean View.

This long-term erosion may be associated with the Little Creek Entrance, but the sand deficit probably exceeds the net longshore transport rate, since occasional eastward transport along East Ocean View may also be deposited irreversibly in the Entrance. Such trapping of eastward transport is to be expected for the following reasons:

a. North winds blowing down the longest Bay fetch will result in an eastward wave component at Little Creek Entrance.

b. Winds from the northwest quadrant are the strongest winds in the area (Figure 6) and would produce eastward longshore transport at the site.

c. The west jetty at the Entrance is relatively short.

Thus, the erosion rate at East Ocean View probably has a value between the net and the gross rates of longshore transport. This process can be important to the design of beach disposal, and deserves further study.

DREDGED MATERIAL DISPOSAL AT EAST OCEAN VIEW

Sand Characteristics. There are 32 sediment samples of East Ocean View available for constructing composites of typical shore material. Dune samples (7) are excluded because these sites are beyond the usual wave-dominated littoral system. Also ignored are all non-dune samples on lines 1 and 2: there the profiles, sediment characteristics, and shore orientation appear considerably different from those further east. Sediment composites will be formed from samples of lines 3 through 8, extending into the historically eroding reach directly downdrift of Little Creek Entrance.

Figure 8 displays two composite grain-size distributions, EOVA and EOVB, formed to represent native sediments on East Ocean View beaches. EOVA was computed giving equal weight to each of 20 samples (berm, foreshore, low-tide terrace, or offshore) from profiles 3 through 8 inclusive. That straight reach of coast appears to have common sediments and processes, so that EOVA is taken as representative of the 15,000 feet of shore immediately west of Little Creek Entrance.

The western limit to appreciable beach erosion lies about midway between profile lines 6 and 7, and the other composite is formed to typify just the eroded region and to give more emphasis to underwater sediments. In EOVB, the offshore sample from line 8 has half the weight, while the other half is composed evenly of samples from berm, foreshore, and low-tide terrace on the same profile. Since the offshore sample is coarser than the beach sands, EOVB is notably coarser than EOVA (Figure 8). The coarser offshore

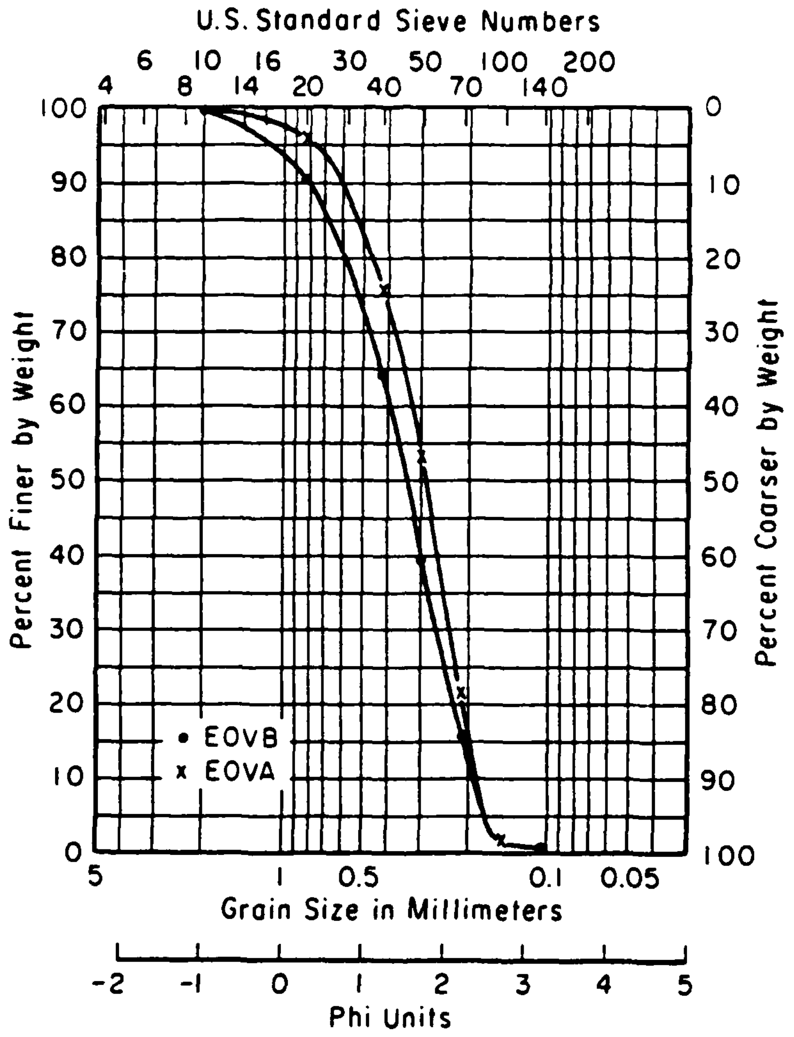

Figure 8. Native composite grain-size distributions for East Ocean View; EOVA is the preferred composite.

sand is thought to be indicative of a basic deficit in sand supply, so EOVA is judged to be more representative of native material for the purposes of beach fill design.

Table 3 summarizes computations relating to the suitability of the two available Channel sands (Figures 2 and 3) as fill for East Ocean View. Mean M and sorting S are determined using D_{16} and D_{84} values from linear interpolation within the cumulative size distributions on phi-probability graph paper. M and S then specify the values of fill factors R according to published design curves (Hobson, 1977; Shore Protection Manual). Standard computation procedures (Table 3) indicate that dredged material from either Area Y or Area Z would be appropriate as fill sediment for the study site, but that Area Y material is better. If EOVA represents East Ocean View beaches, the Area Y material is about ideal in size characteristics for eroded beaches of East Ocean View.

The two fill factors, R_A and R_D, in Table 3B constitute estimates of the gross initial volume needed on the beach to provide a net unit volume of durable beach material. For Area Y material, R_A and R_D are 1.22 and 1.00, respectively. This implies required overfills of only 22% (R_A) or even 0% (R_D) indicating that losses due to size mismatch are expected to be small. The durability factor, R_J, estimates the relative rate of beach erosion with fill sediment as opposed to the historical rate at the site with native sediment. For Area Y material, the value much less than unity (0.28) suggests that material from Area Y will be 3.6 times more durable than existing beach sands (according to standard interpretation of the durability factor).

Table 3. Basic results in beach disposal computations relating to East Ocean View beaches, for two potential dredging areas in eastern Thimble Shoal Main Channel.

A. Description of Sediments (phi units)

Parameter	Native Beach EOVA	Potential Dredged Material Area Y	Potential Dredged Material Area Z
D_{16}	1.00	0.36	1.09
D_{50}	1.77	1.85	2.10
D_{84}	2.31	2.68	3.01
$M = (D_{84}+D_{16})/2$	1.655	1.52	2.05
$S = (D_{84}-D_{16})/2$	0.655	1.16	0.96

B. Compatibility Measures of Potential Dredged Materials with EOVA

	Adjusted SPM Volume Factor R_A	Durability Factor R_J	Dean Fill Factor R_D
Area Y	1.22	0.28	1.00
Area Z	1.60	1.00	1.40

Preliminary Design for Disposal. As of the summer of 1983, the East Ocean View shore was clearly eroded along about 6000 feet from the Little Creek Entrance westward to about midway between profile lines 6 and 7. This present extent of shore erosion agrees with historical data reported by Fleischer, et al. (1977). However, it does not account for the unknown effects of dredged material from Little Creek Entrance and Pretty Lake, placed west of that Entrance during fall 1983 through spring 1984.

The fill section developed here is a preliminary design fairly appropriate to the entire eroded reach of East Ocean View. It is based on this straightforward concept: the ultimate effect of a beach fill is to provide a seaward advance of the entire nearshore profile (which is initially and finally the nearly-equilibrium form for the particular site). Here the typical existing profile is taken to be that measured at line 8, near the middle of the eroded reach. Figure 9 displays a slightly idealized version of that surveyed profile, along with the expected effects of adding dredged material.

The Figure 9 example is based on the intended total berm width of 80 feet, consisting of the existing 30 feet (average) plus an additional 50 feet composed of dredged material. This design berm width of 80 feet matches the maximum natural berm width in the study area (at line 3). Other design parameters are the berm elevation of +6 feet MLW (for the natural upper berm), the wetted foreshore slope of 1 on 11, and the seaward limit to appreciable sand redistribution of -13 feet MLW. Compromising at 110% between the two Area Y overfill factors in Table 3, required disposal

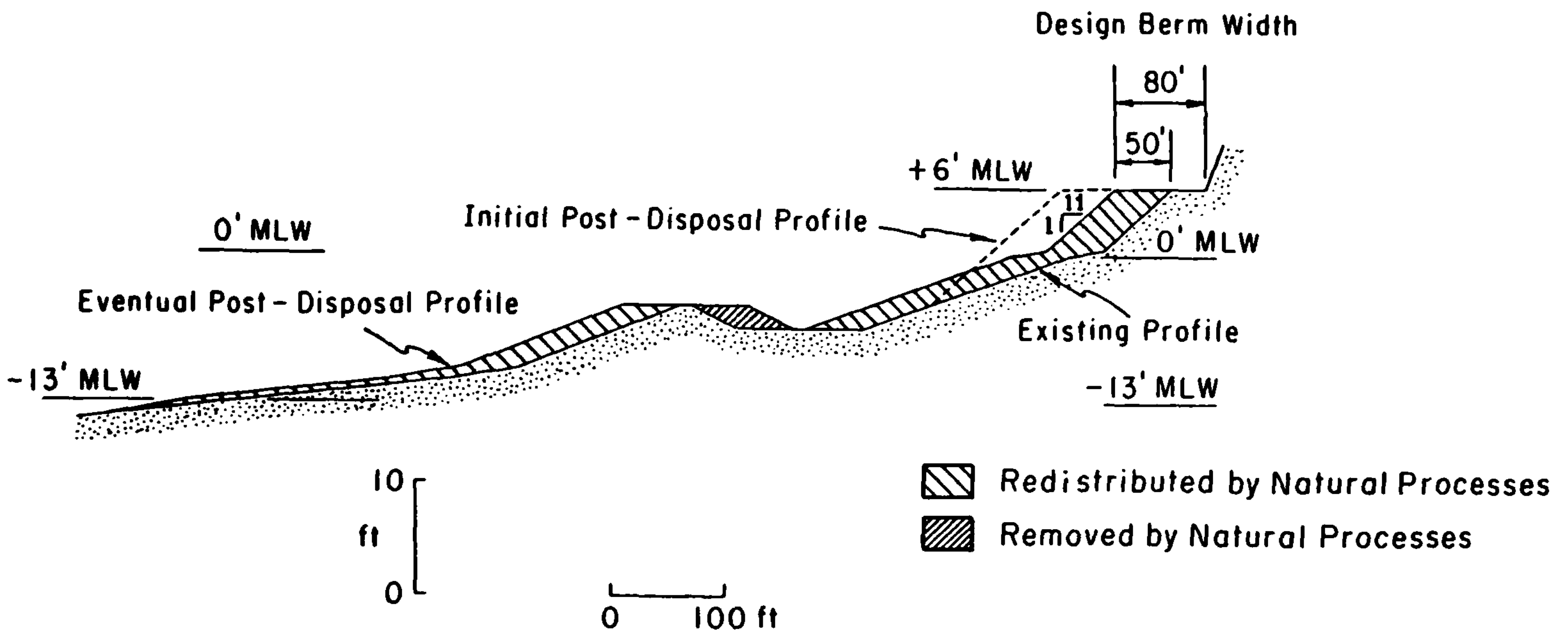

Figure 9. PROFILES IN PRELIMINARY DESIGN OF BEACH DISPOSAL AT EAST OCEAN VIEW

volume for the design geometry in Figure 9 is computed to be 165,000 cubic yards, and the initial build-out distance beyond the existing berm is about 100 feet.

These last two values may not constitute an adequate reservoir of placed sediment. The initial berm advance of 100 feet does not appear adequate for smoothing out present shoreline irregularities, e.g., at the large bulkheaded structure projecting into the Bay just west of profile line 8, so that a continuous sand beach might not result from such a fill. In addition, using the estimate developed previously that net nearshore erosion has averaged 22,500 cubic yards per year over the 6000 feet or eroded shore, the disposal volume given above would provide only a seven-year reservoir by basic arithmetic. (Note, however, that the durability factor stated in Table 3, if taken at face value, would extend this duration to about 23 years because of differences in disposal and native sand characteristics.)

A larger volume of disposal material will extend the fill lifetime, provide a beach of increased recreational value and storm-protection capacity, and maximize the use of dredged material from Thimble Shoal Channel. However, maximum advisable constructed beach advance seems constrained by potential eastward transport around the west jetty and into Little Creek Entrance. Offshore of the seaward face of the bar, the existing profile (Figure 9) has a very slight slope (about 1 on 95). The break in slope between the bar and this 1 on 95 surface should be kept landward of the end of the west jetty. From limited available information, a prudent design maximum for the constructed increment in berm width is about 100 feet (twice that shown in Figure 9). That design configuration corresponds to a disposal volume of 330,000 cubic yards, an initial build-out distance of 185

feet beyond the existing berm, and at least a 13-year reservoir of sand on this feeder beach for the coast further west (or 47 years according to the durability-factor viewpoint). If a longer reservoir lifetime is desired, additional material should be placed away from the Little Creek Entrance, namely between profile lines 7 and 8, to minimize the possiblity of occasional eastward littoral transport carrying sand into the Entrance Channel.

These design examples along the lines illustrated in Figure 9 are subject to a fundamental criticism: adding sand to profiles in the eroded condition of that on line 8 may be expected to result in a higher bar perhaps closer to shore (as at lines 3-6), rather than the simple seaward bar displacement considered here. Suppositions about such bar growth would introduce additional uncertainties into a quantitative design, and the present procedure is thought to be conservative in the sense of overestimating offshore changes associated with a beach disposal at this site. However, possible bar growth should be examined in refining the preliminary designs provided here. Final disposal design for disposal of Channel material on beaches just west of Little Creek Entrance must be based on better definition of nearshore conditions presently existing over this entire region, including any durable positive effects of the recent placement of material dredged from the Entrance and from Pretty Lake.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Present investigations establish that it is feasible to dispose of sand available from the anticipated deepening of Thimble Shoal Main Channel on the eroded coast of East Ocean

View, Norfolk, Virginia. This determination is mainly based on new field data: a survey of 8 profile lines (Figures 4 and 5) and sieve analyses (Appendix A) of 32 sediment samples from the study area. These data define the westward extent of erosion from the Little Creek Entrance and yield a representative composite (Figure 8) for native beach sands. Other useful information includes: charted local hydrography (Figures 1, 7); wind and sea data (Table 1, Figure 6); and estimated wave conditions, limit depths, and basic sand transport effects (Table 2, Appendix B).

Previous investigations have shown that there are two promising dredging areas for sand recovery within Thimble Shoal Channel (Figure 2), and known characteristics of materials in those areas (Figure 3) are used to assess their compatibility with native sand along East Ocean View (Table 3). Although Dredging Area Z at the eastern channel end would provide an adequate beach material, Area Y gives a better match to native beach sand and is less distant. Up to 60% of available material in Area Y was previously recommended for disposal along Willoughby Spit, but the remaining 350,000 cubic yards appears to be sufficient sand volume for improving East Ocean View beaches according to a preliminary design (Figure 9).

Sand from Area Y in Thimble Shoal Main Channel is very suitable beach material on the eroded shore just west of Little Creek Entrance. Along the 6,000 feet of shoreline, uniform placement of 330,000 cubic yards of Area Y material should result in a durable shore advance of about 100 feet, nearly the maximum thought advisable. Ultimately, that material is expected to erode and provide littoral drift to beaches further westward, but the volume stated above is estimated to constitute a supply adequate for a period

estimated as at least 13 years. If a longer-lived beach stockpile is desired, additional dredged material should be applied to the western half of the eroded reach, near profile lines 7 to 8 in the East Ocean View study area.

Figures 10 and 11 summarize basic geometry involved in disposal of dredged Channel sand at East Ocean View. Figure 10 displays important vertical elevations, and Figure 11 shows the horizontal relation between dredging and disposal sites. That summation also includes distances and directions to the underwater stockpile site for Area Y sand recommended in a previous report (Hallermeier, et al., 1984b). At this sheltered offshore site about 2 miles ENE of Willoughby Spit, sand can be safely stored and recovered for use on beaches when needed.

To develop an optimum final design for dredged material disposal in the study area, additional investigation of East Ocean View is recommended. Detailed sounding of the entire eroded reach should be done to provide accurate knowledge of present conditions and yield more representative profiles for use in designing the placement section and basic plan. In order to evaluate seasonal profile changes, if any, 4 selected profile lines should be surveyed once a quarter for a year. These 4 lines need to be very accurately located in order to justify any interpretations of the results. A survey of the region around the west jetty at Little Creek Entrance should be done to assess the potential for eastward littoral transport which affects design of the disposal. An historical analysis should be made of the quantities and location of previous dredging at Little Creek Entrance. This can contribute valuable information on net and gross longshore transport rates. A detailed drogue study of local

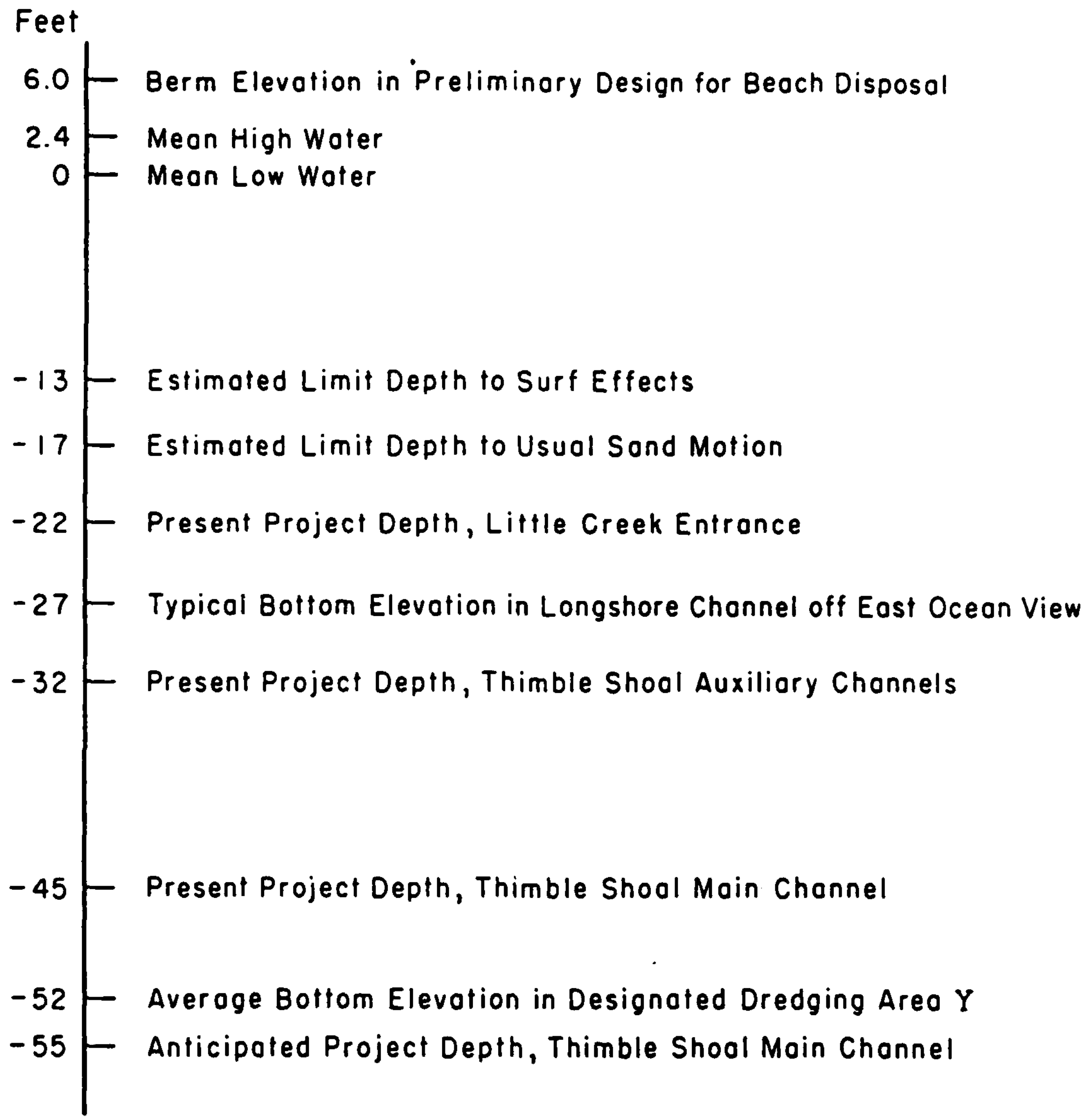

Figure 10. IMPORTANT ELEVATIONS FOR DISPOSAL OF DREDGED SAND AT EAST OCEAN VIEW, NORFOLK, VIRGINIA

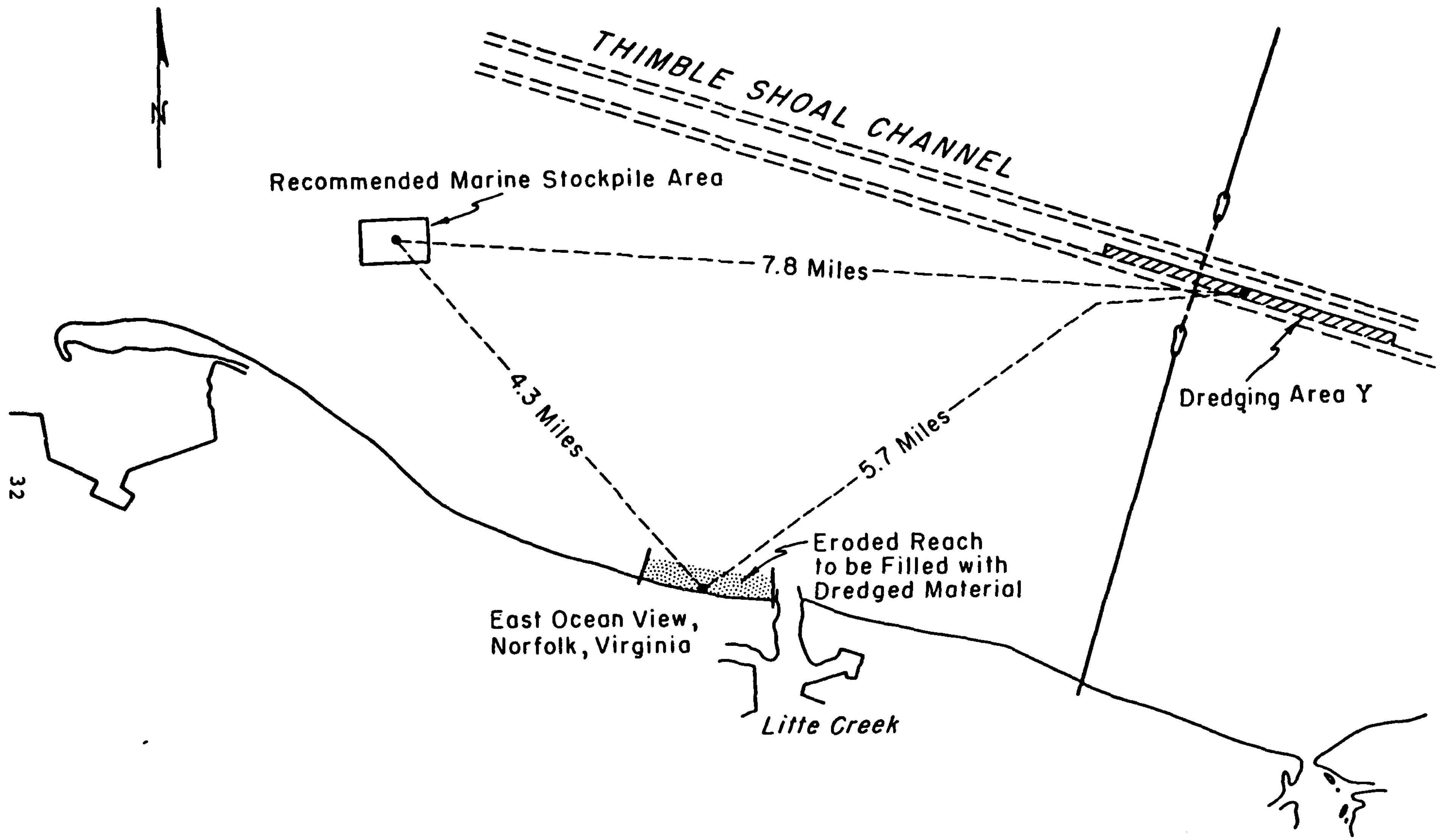

Figure 11. RELATIONS BETWEEN DREDGING, STOCKPILE AND DISPOSAL AREAS

tidal currents at spring and neap tides should be done to evaluate their importance in sand transport. Finally, it would be useful to benefit from recent placement of dredged material west of the Entrance by periodic sediment sampling in connection with the quarterly profiles recommended above.

In addition to study of East Ocean View, it is necessary to verify the extent and continuity of the sand deposit in Area Y, which is now defined by only 3 cores, all on the south side of the channel.

REFERENCES

P. Fleischer, G.J. McRee, and J.J. Brady, 1977. "Beach dynamics and erosion control, Ocean View Section, Norfolk, Virginia," Technical Report No. 30, Institute of Oceanography, Old Dominion University, Norfolk, Virginia, 185 pp.

R.J. Hallermeier, 1981. "A profile zonation for seasonal sand beaches from wave climate," Coastal Engineering, Vol. 4, pp. 253-277.

R. Hallermeier, J.W. Lott, C. Galvin, and J.W. Holton, 1984a. "Feasibility Study For Disposal of Dredged Material From Norfolk Harbor Channel Deepening on Fort Story Beaches," Report for Waterway Surveys & Engineering, Ltd., Virginia Beach, Virginia, 82 pp.

R. Hallermeier, J.W. Lott, C. Galvin, and J.W. Holton, 1984b. "Preliminary Design for Disposal of Dredged Material From Thimble Shoal Channel at West Ocean View Beaches," Report for Waterway Surveys & Engineering, Ltd., Virginia Beach, Virginia, 76 pp.

S.D. Hicks, H.A. DeBaugh, Jr., and G.R. Thomas, 1983. "Sea level variations for the United States, 1855-1980," National Ocean Service, Rockville, Maryland, 170 pp.

R.D. Hobson, 1977. "Review of design elements for beach fill evaluation," Technical Paper No. 77-6, U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, 51 pp.

E.P. Meisburger, 1977. "Geomorphology and sediments of the Chesapeake Bay entrance", Technical Memorandum No. 38, U.S. Army Coastal Engineering Research Center, Washington, D.C. 61 pp.

National Ocean Survey, 1982a. "Tide Tables 1983 - East Coast of North and South America Including Greenland," Rockville, Maryland, 285 pp.

National Ocean Survey, 1982b. "Tidal Current Tables 1983 - Atlantic Coast of North America," Rockville, Maryland, 234 pp.

E.F. Thompson, 1977. "Wave climate at selected locations along U.S. coasts," Technical Report No. 77-1, U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia, 346 pp.

U.S. Army Coastal Engineering Research Center, 1977. "Shore Protection Manual," 3rd ed., U.S. Government Printing Office, Washington, D.C.

BIBLIOGRAPHY

M.M. Das, 1974. "Beach Erosion Study, Little Creek Naval Amphibious Base, Virginia", Provisional Technical Report TR-248, Naval Oceanographic Office, Washington, D.C., 69 pp.

R.W. James and B.A. Anderson, 1974. "A Study of Wave Conditions at Little Creek Amphibious Base, VA," NAVOCEANO Technical Note No. 6150-26-74.

D.R. Richards, and M.R. Morton, 1983. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-83-13, USAE Waterways Experiment Station, Vicksburg, Mississippi, 371 pp.

U.S. Army Corps of Engineers, 1952. "Lynnhaven Bay and Inlet, Virginia; Model Investigation," TM No. 2-348, USAE Waterways Experiment Station, Vicksburg, Mississippi.

APPENDIX A

SEDIMENT CHARACTERISTICS WITHIN STUDY AREA, EAST OCEAN VIEW, NORFOLK, VIRGINIA

The following plots of characteristics of sampled sediments display the median and representative extreme diameters: D_{50}, D_{16}, and D_{84}. These values have been interpolated from sieve analyses at half-phi intervals. Grain diameters in phi units are plotted against location along the coast of East Ocean View, for each nominally comparable sampling station. Figures A1-A5 pertain to samples from dune, berm, foreshore, low-tide terrace, and offshore, respectively.

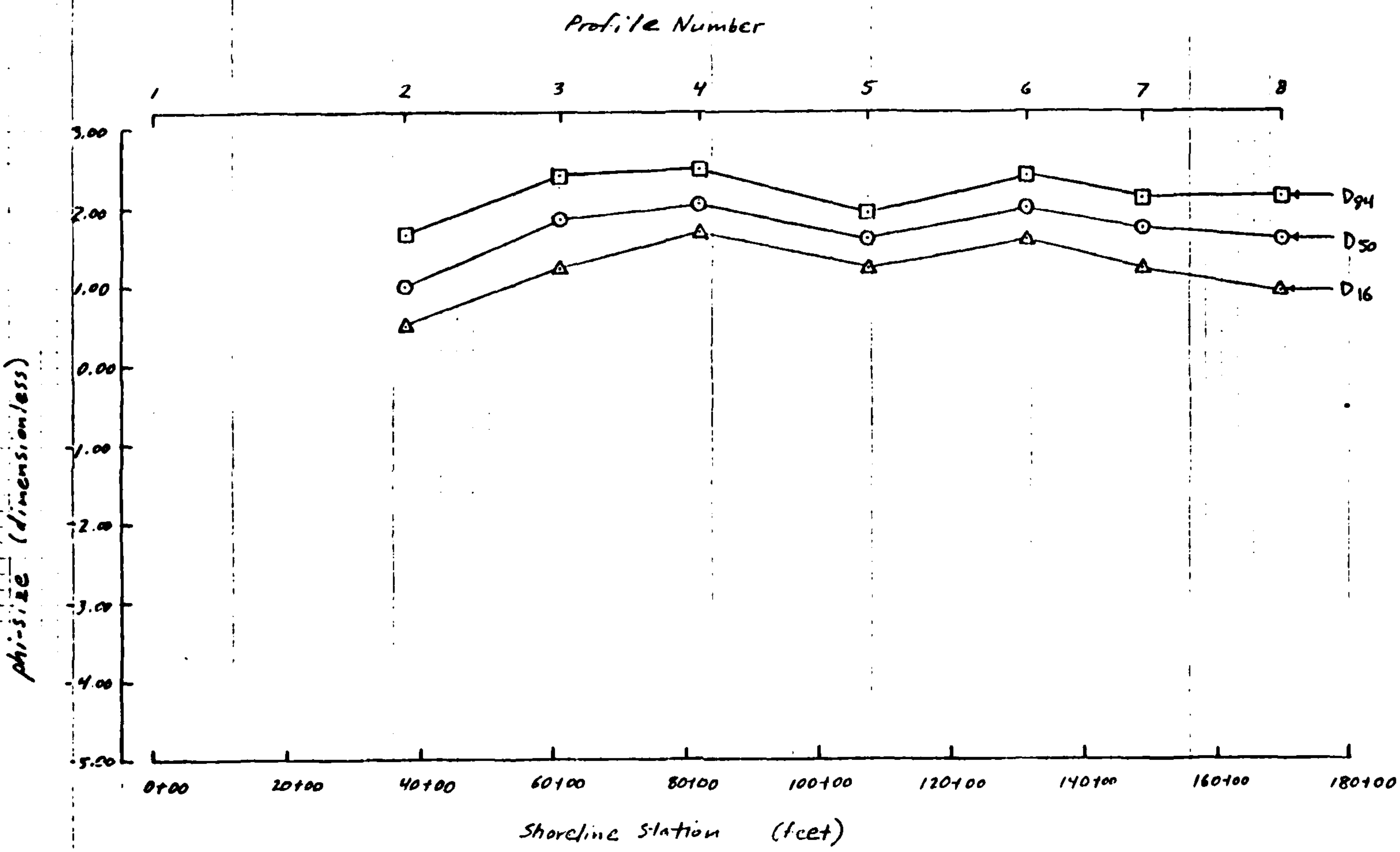

FIGURE A1. DUNE SAMPLES AT EAST OCEAN VIEW

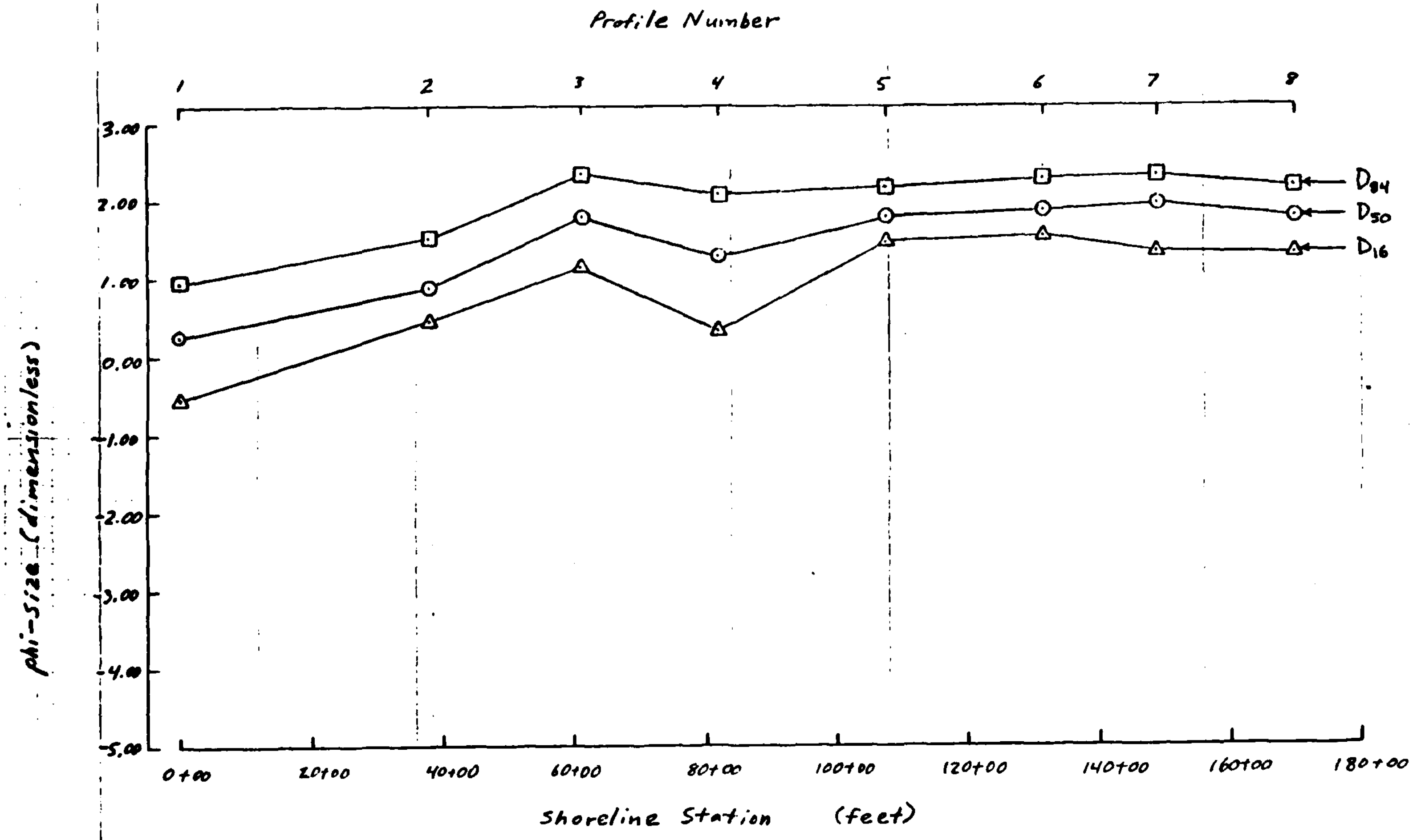

FIGURE A2. BERM SAMPLES AT EAST OCEAN VIEW

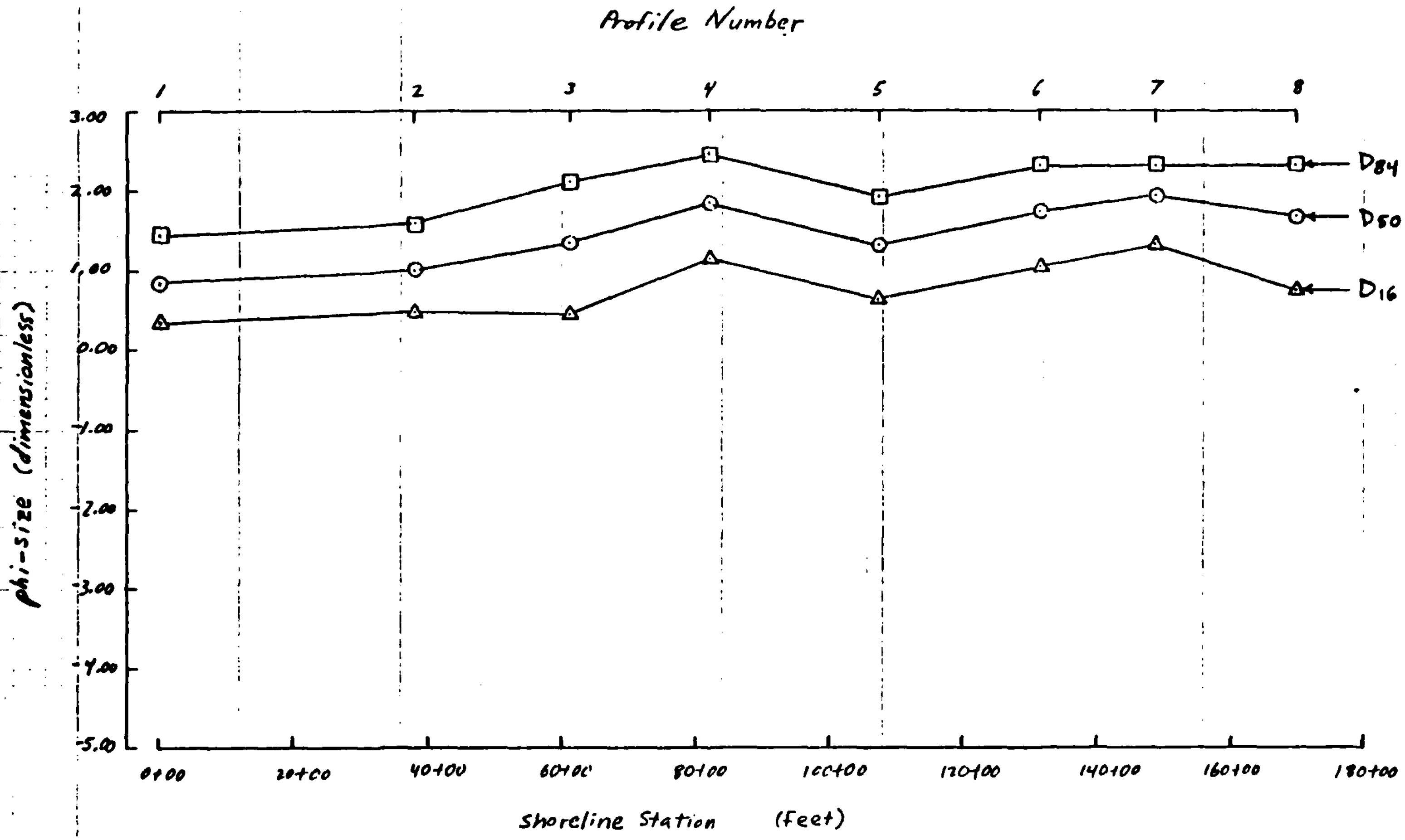

FIGURE A3. FORESHORE SAMPLES AT EAST OCEAN VIEW

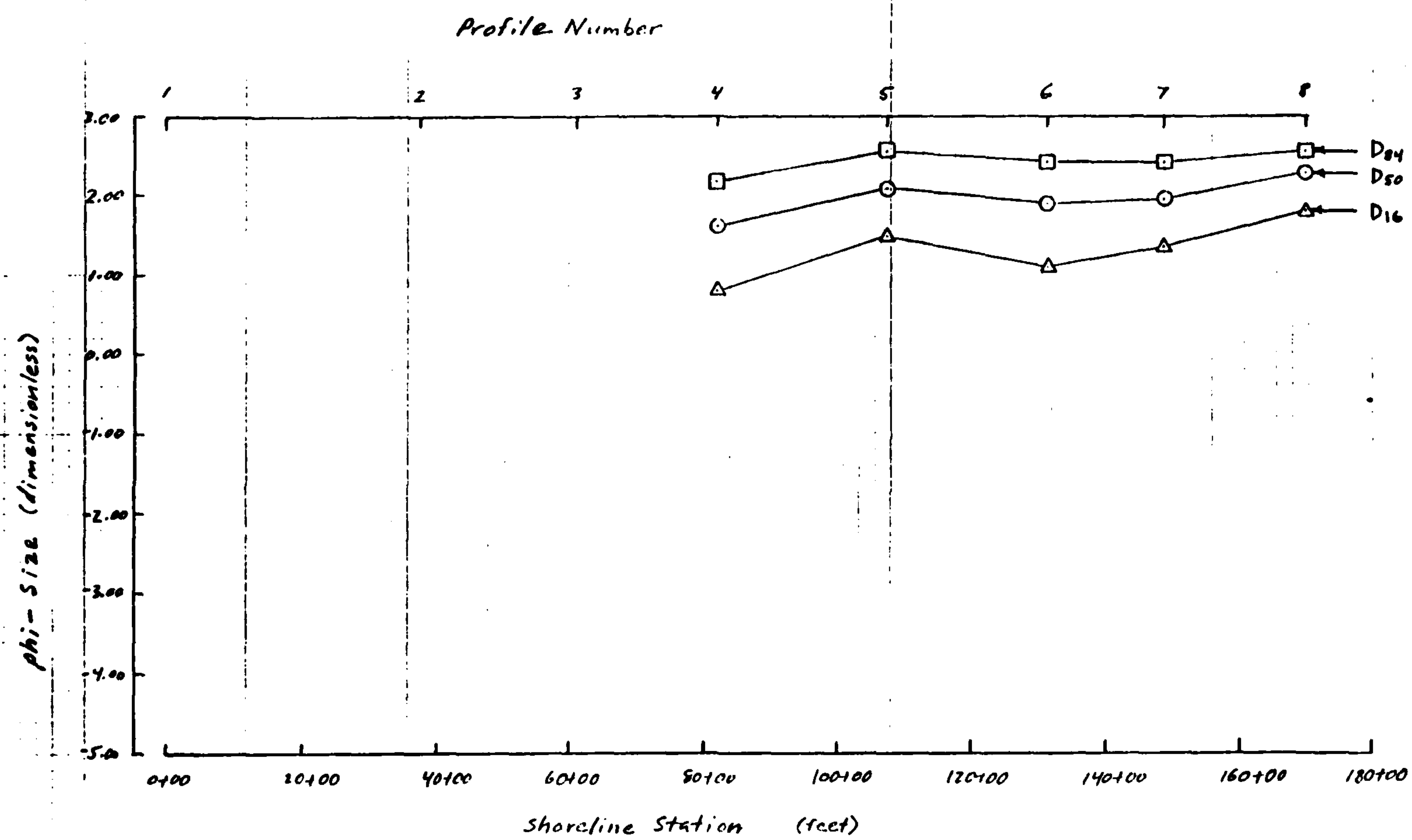

FIGURE A4. LOW-TIDE-TERRACE SAMPLES AT EAST OCEAN VIEW

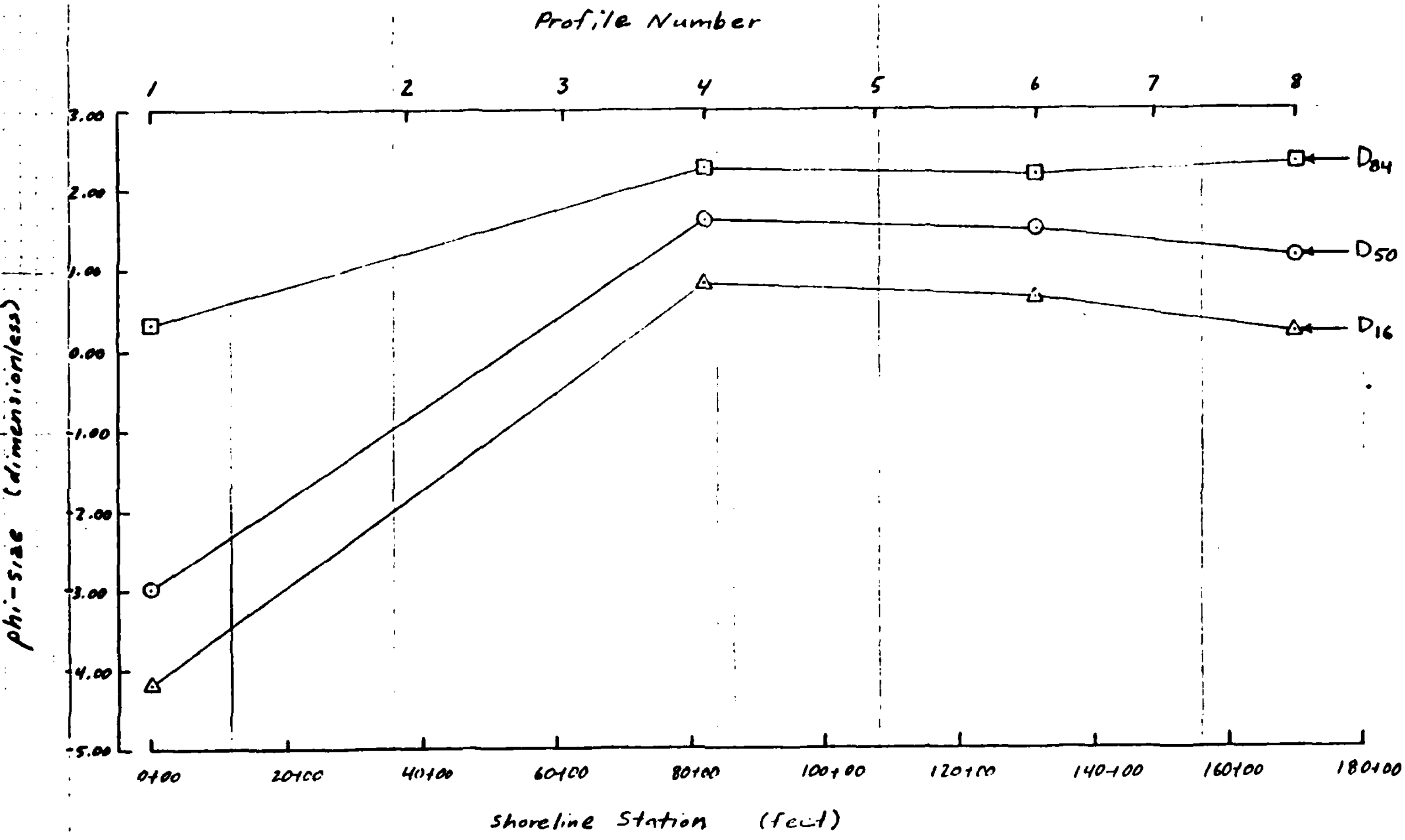

FIGURE A5. OFFSHORE SAMPLES AT EAST OCEAN VIEW

APPENDIX B

COMPUTATIONS OF WAVES FROM CHESAPEAKE BAY

The topic here is analyses regarding the exposure of the East Ocean View shore to major fetches within Chesapeake Bay. Procedures used are from Sections 3.43 and 3.61 of the 1977 edition of the Shore Protection Manual. Usual results are forecast values of significant wave height and period considering wind and wave directions, for direct use in assessing rates of littoral drift. However, the immediate aim is to compare the Bay exposure of the East Ocean View study area to that at a wave-gage location on South Thimble Island of the Chesapeake Bay Bridge-Tunnel.

Figures B1 and B2 show the geometrical exposures to the Chesapeake Bay of the gage site and of the eastern (eroded) end to the study area. For the Bridge-Tunnel wave gage, the central fetch radial in Figure B1 is oriented at a compass direction of about 355° and the effective fetch computation in Table B1 reveals that subsidiary fetches to either side are fairly balanced. A site near profile line 8 in East Ocean View is analyzed in Figure B2 and the associated Table B2; here the central fetch radial is appropriately placed near 005°.

Figure B3 shows the diagram used in estimating a representative water depth for the major region of Bay-wave generation. Depths along 5 east-west transects across the Bay are extracted where the central and the two adjacent radials intersect them. Mean depth of soundings for each

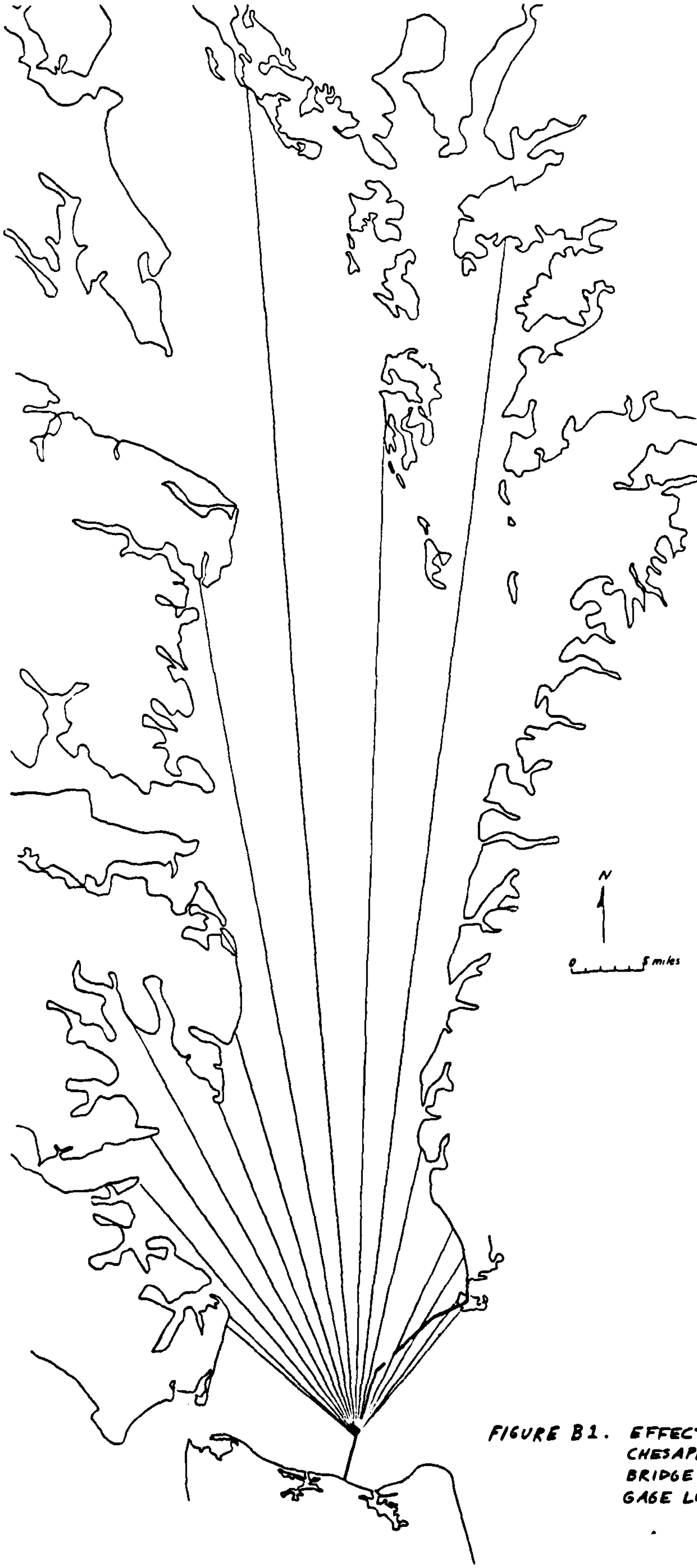

FIGURE B1. EFFECTIVE FETCH-
CHESAPEAKE BAY
BRIDGE-TUNNEL
GAGE LOCATION

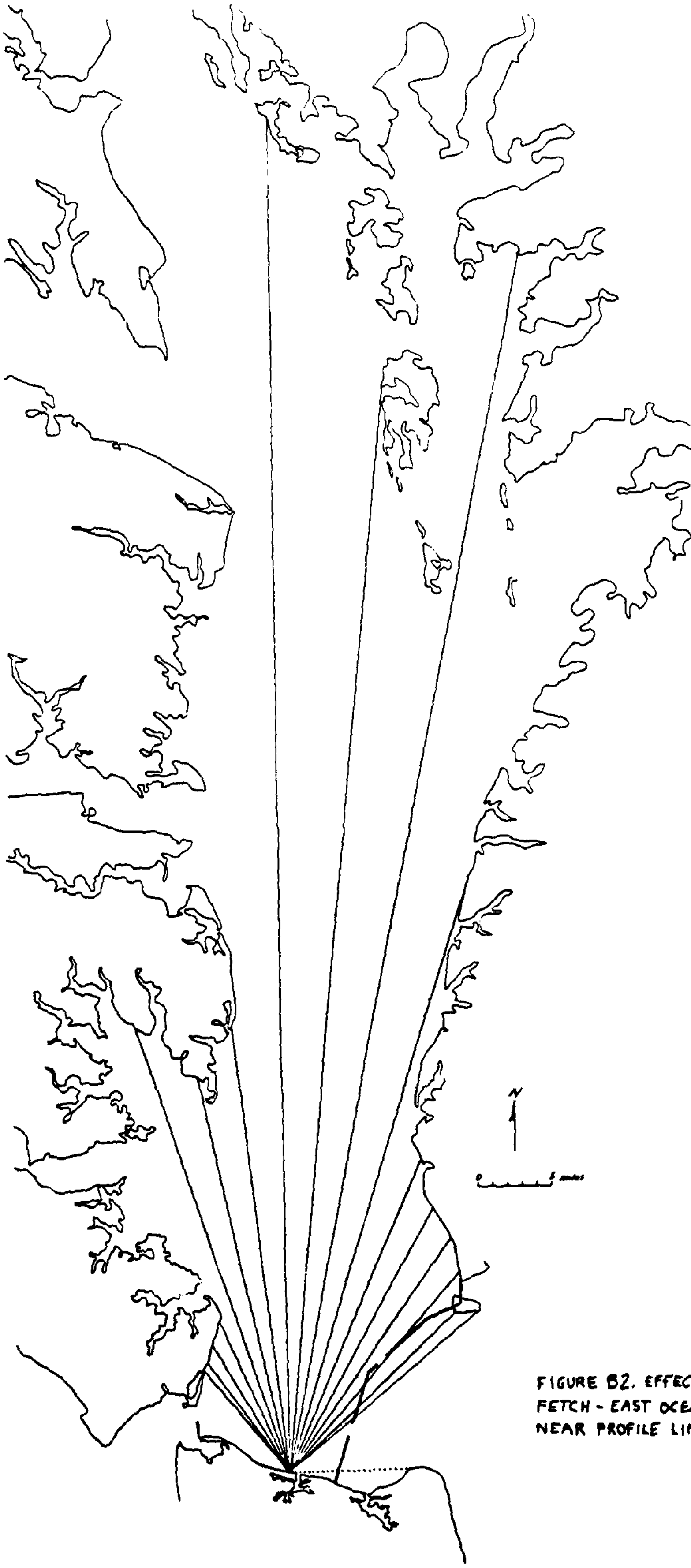

FIGURE B2. EFFECTIVE FETCH - EAST OCEAN VIEW NEAR PROFILE LINE B.

α	$\cos^2\alpha$	r	$X_i \cos\alpha$
42	.552	3.8	2.10
36	.655	7.3	4.78
30	.750	7.9	5.93
24	.835	10.1	8.43
18	.904	7.8	7.05
12	.957	9.1	8.71
6	.990	18.7	18.51
0	1.000	29.1	29.10
6	.990	21.4	21.19
12	.957	25.8	24.69
18	.904	6.3	5.70
24	.835	(blocked by Bridge-Tunnel)	
30	.750	4.9	3.68
36	.655	4.5	2.95
42	.552	3.7	2.04
$\Sigma =$	13.512		144.86

$$F_{eff} = \frac{\Sigma X_i \cos\alpha}{\Sigma \cos\alpha} = \frac{144.86}{13.512} = 10.72 \text{ in.}$$

(at a scale of 1:200,000
1 in. = 3.16 statute miles)

$$F_{eff} = 10.72 \times 3.16 = \boxed{33.9 \text{ miles}}$$

EFFECTIVE FETCH CALCULATION FOR CHESAPEAKE BAY BRIDGE - TUNNEL GAGE LOCATION.
TABLE B1.

α	$\cos\alpha$	r	X_i	$X_i \cos\alpha$
42	.743	3.0	2.23	1.66
36	.809	3.2	2.59	2.09
30	.866	3.6	3.12	2.70
24	.914	10.1	9.23	8.44
18	.951	8.7	8.27	7.87
12	.978	9.6	9.39	9.18
6	.995	29.2	29.05	28.91
0	1.000	23.4	23.40	23.40
6	.995	26.6	26.47	26.33
12	.978	13.1	12.81	12.53
18	.951	7.3	6.94	6.60
24	.914	6.5	5.94	5.43
30	.866	6.1	5.28	4.57
36	.809	5.6	4.53	3.67
42	.743	4.9	3.64	2.71
$\Sigma =$	13.512			146.09

$$F_{eff} = \frac{\Sigma X_i \cos\alpha}{\Sigma \cos\alpha}$$

$$= \frac{146.09}{13.512} = 10.81 \text{ in.}$$

(at a scale of 1:200,000
1 in. = 3.16 statute miles)

$$F_{eff} = 10.81 \times 3.16$$

$$= \boxed{34.2 \text{ miles}}$$

EFFECTIVE FETCH CALCULATION FOR EAST OCEAN VIEW, VIRGINIA

TABLE B2.

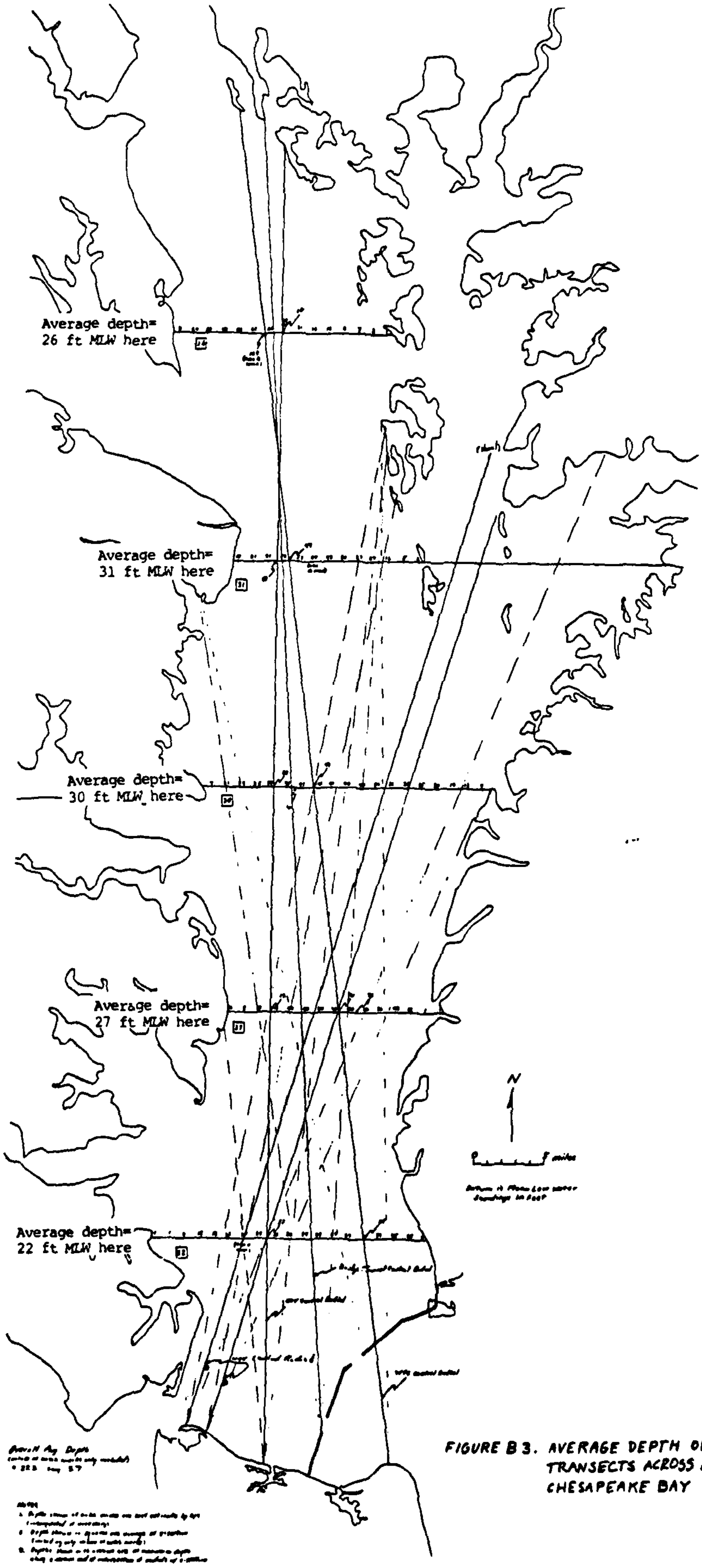

FIGURE B 3. AVERAGE DEPTH ON TRANSECTS ACROSS LOWER CHESAPEAKE BAY

fetch analysis is then computed. Resultant values are nearly the same: 35 feet MLW for the gage site and 36 feet MLW for the East Ocean View site.

Table 2 presents a few wave forecasts for conditions appropriate at either site. Those forecasts specify only that winds are approximately from the north. The difference of 10° in orientation of major exposure for the sites is small compared to the angular resolution (22.5°) of available wind data, so that wind direction was not specified exactly for wave forecasts.

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LETTER OF TRANSMITTAL

DATE: 25 Jun 1984 | JOB NO: EOV

ATTENTION: Woody

RE: EOV ~~WOV~~ Revised Report (originals)

TO: Mr. James W. Holton, President
Waterway Surveys & Engineering, Ltd.
321 Cleveland Place
Virginia Beach, Virginia 23462

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via ______ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
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COPIES	DATE	NO.	DESCRIPTION
1	25 Jun 84		"Feasibility of Disposing Thimble Shoal Channel Sediment at
			East Ocean View Beaches, Norfolk, Virginia"
1	20-25 Jun		Marked-up rough portions of the above report, used in making up
			the complete, revised original manuscript above
1	22 Jun		Invoice for Word Processing services by Sheila Zukor

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REMARKS: This is the complete revised version of the EOV report including revisions in accordance with changes suggested by the Corps' reviewer(s) and Woody Holton.

Note mention of drawing on page iii to be supplied by WS&E. I have not seen a copy of this.

Sheila is now away on vacation until 10 July 1984. There may be typos needing correction. If so, it is probably best you do them in your office.

COPY TO ______

SIGNED: CG

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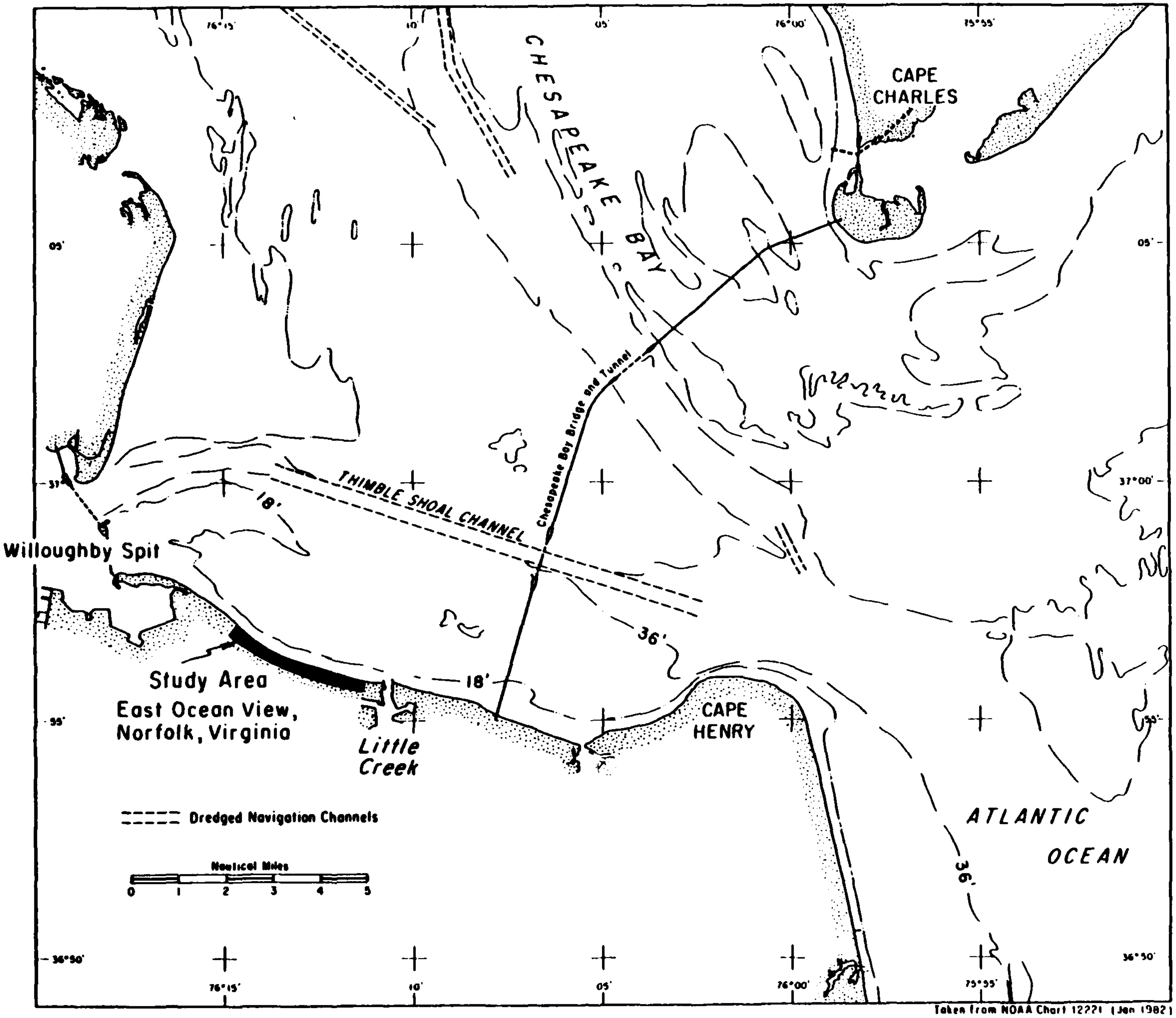

Figure 1. Chesapeake Bay Entrance with relevant sites and depth contours.

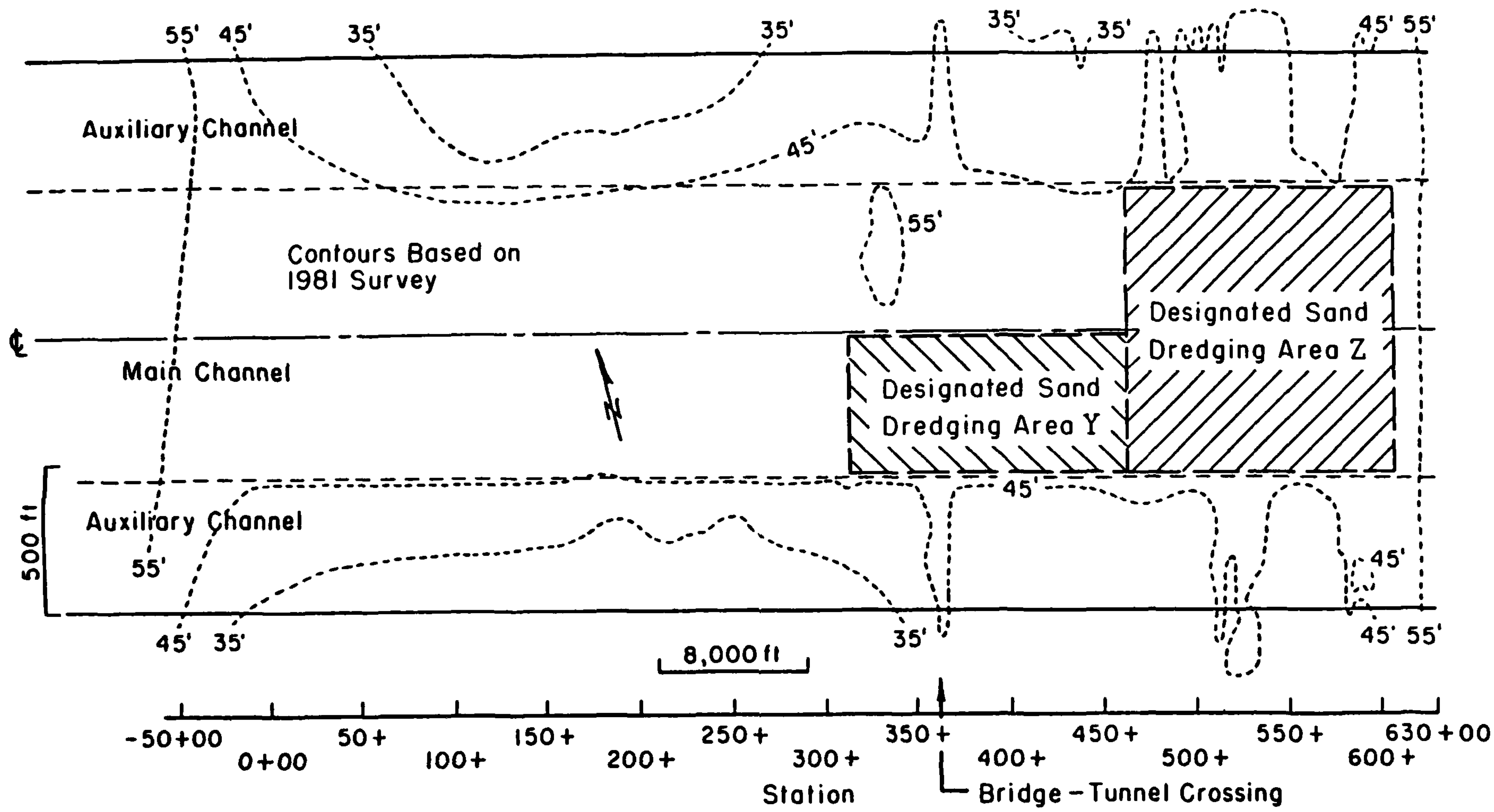

Figure 2. Designated sand dredging areas in eastern half of Thimble Shoal Channel. Cross-channel scale exaggerated 16 times.

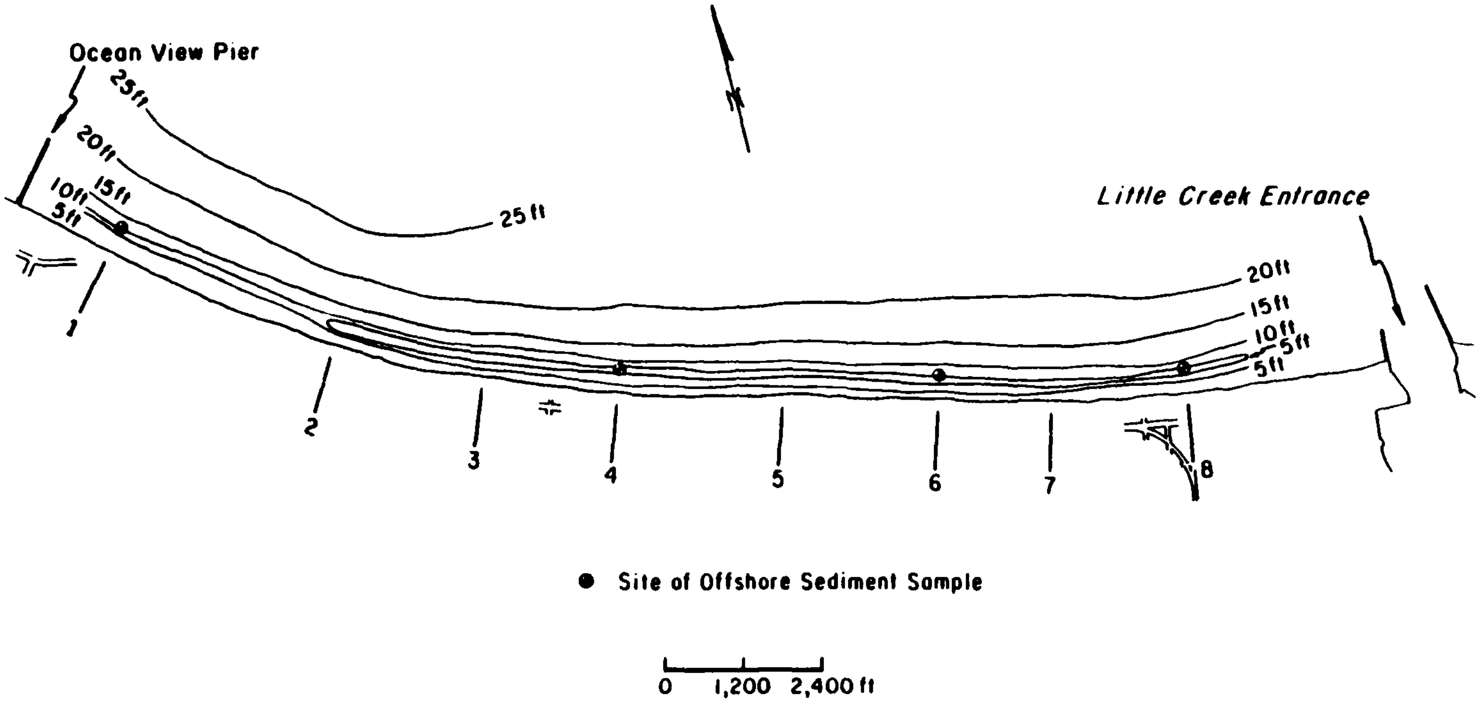

Figure 4. Location of profile lines and resultant water-depth contours (MLW) in August 1983 survey of East Ocean View.

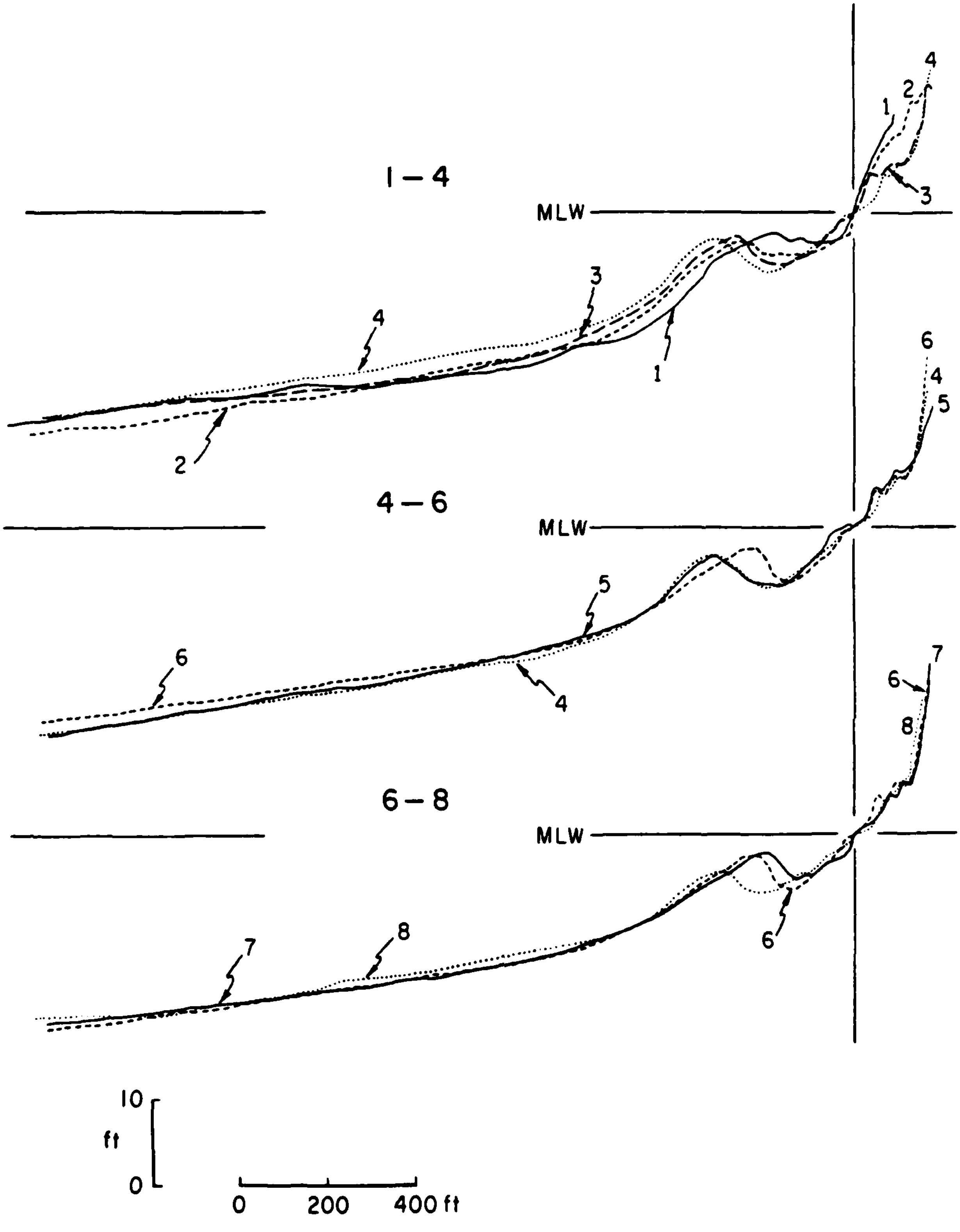

Figure 5. Beach and nearshore profiles at East Ocean View in August 1983.

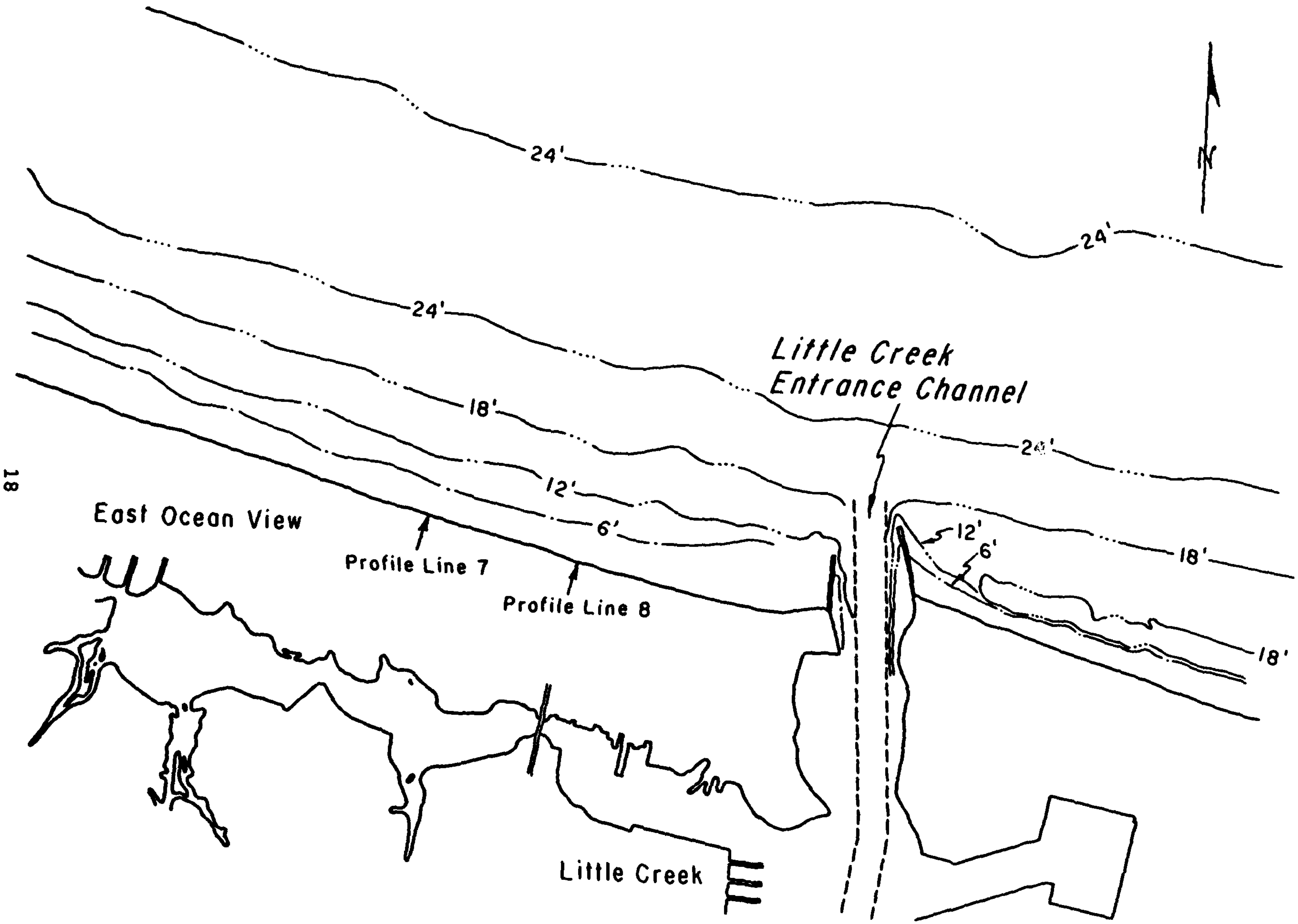

Figure 7. Charted hydrography near Little Creek Entrance (NOS Chart 12256; June 1982).

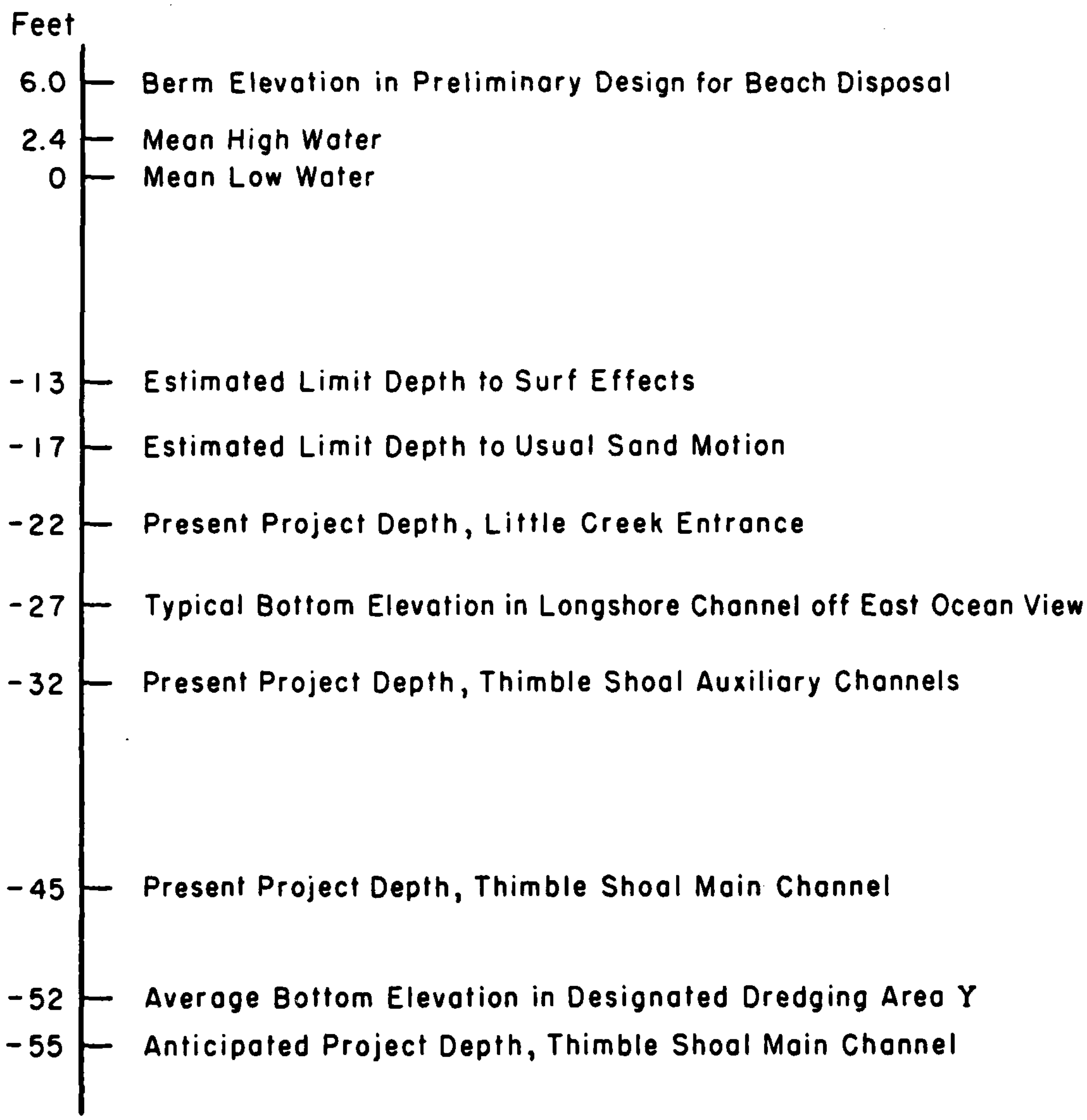

Figure 10. IMPORTANT ELEVATIONS FOR DISPOSAL OF DREDGED SAND AT EAST OCEAN VIEW, NORFOLK, VIRGINIA

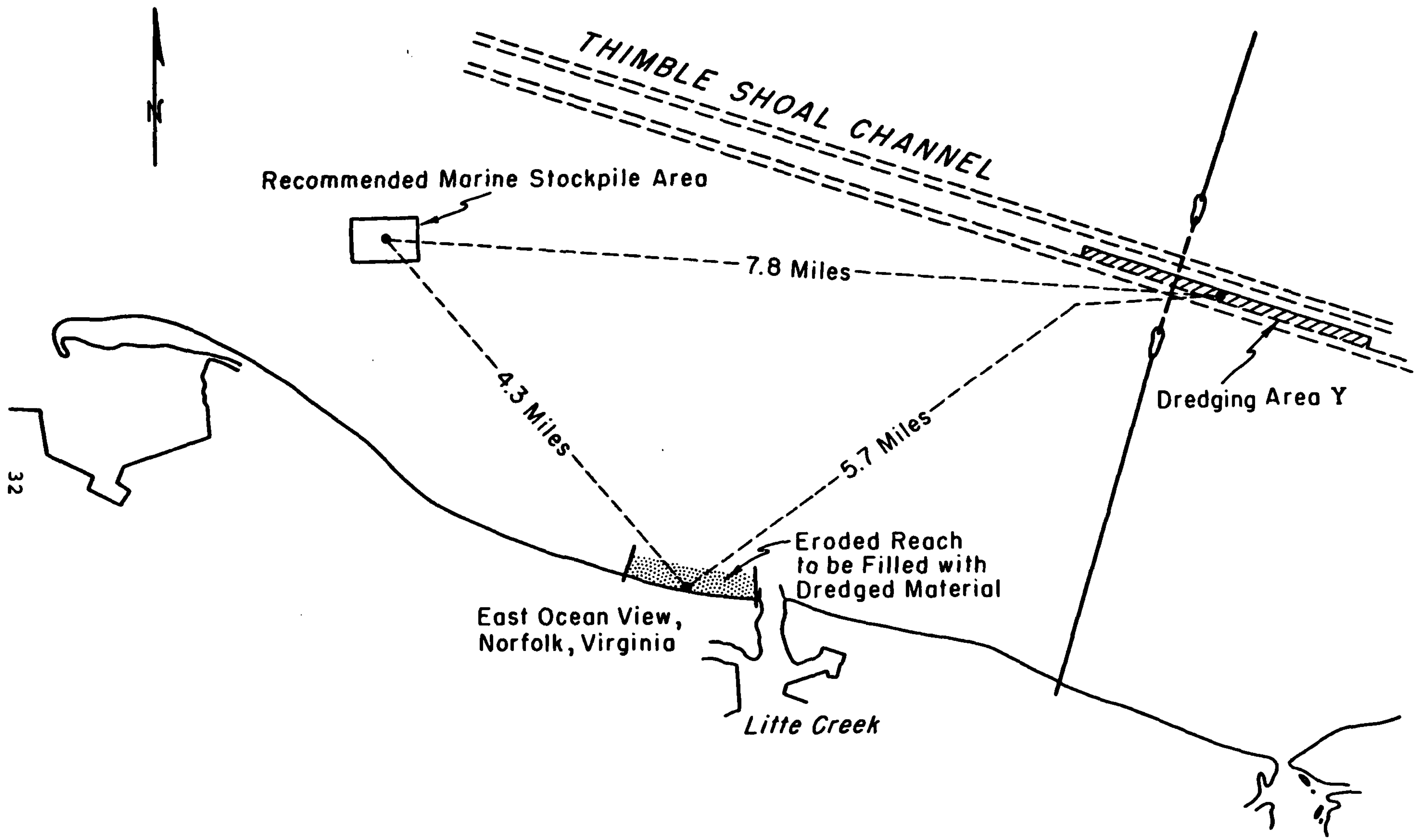

Figure 11. RELATIONS BETWEEN DREDGING, STOCKPILE AND DISPOSAL AREAS

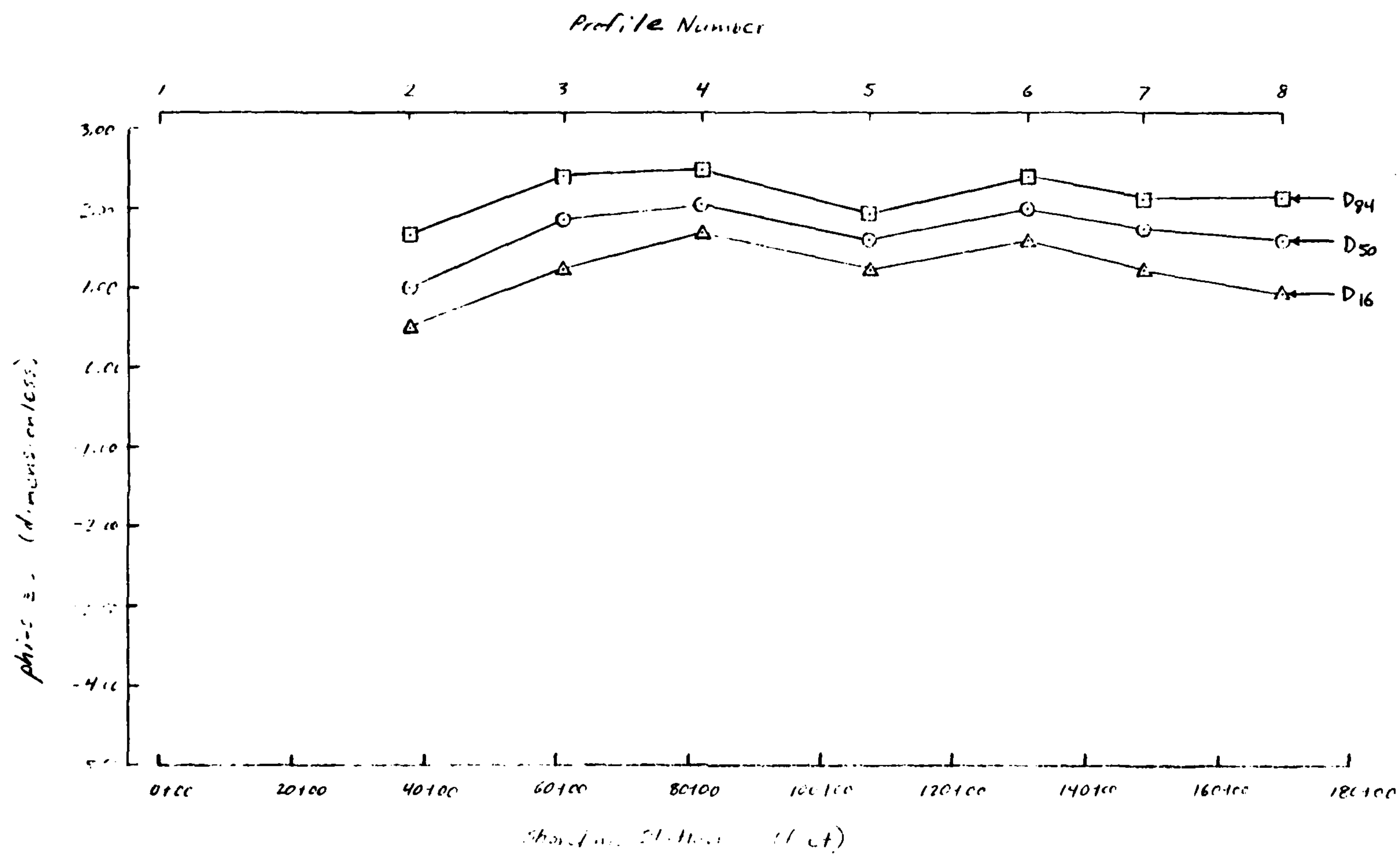

FIGURE A1. DUNE SAMPLES AT EAST BAY VIEW

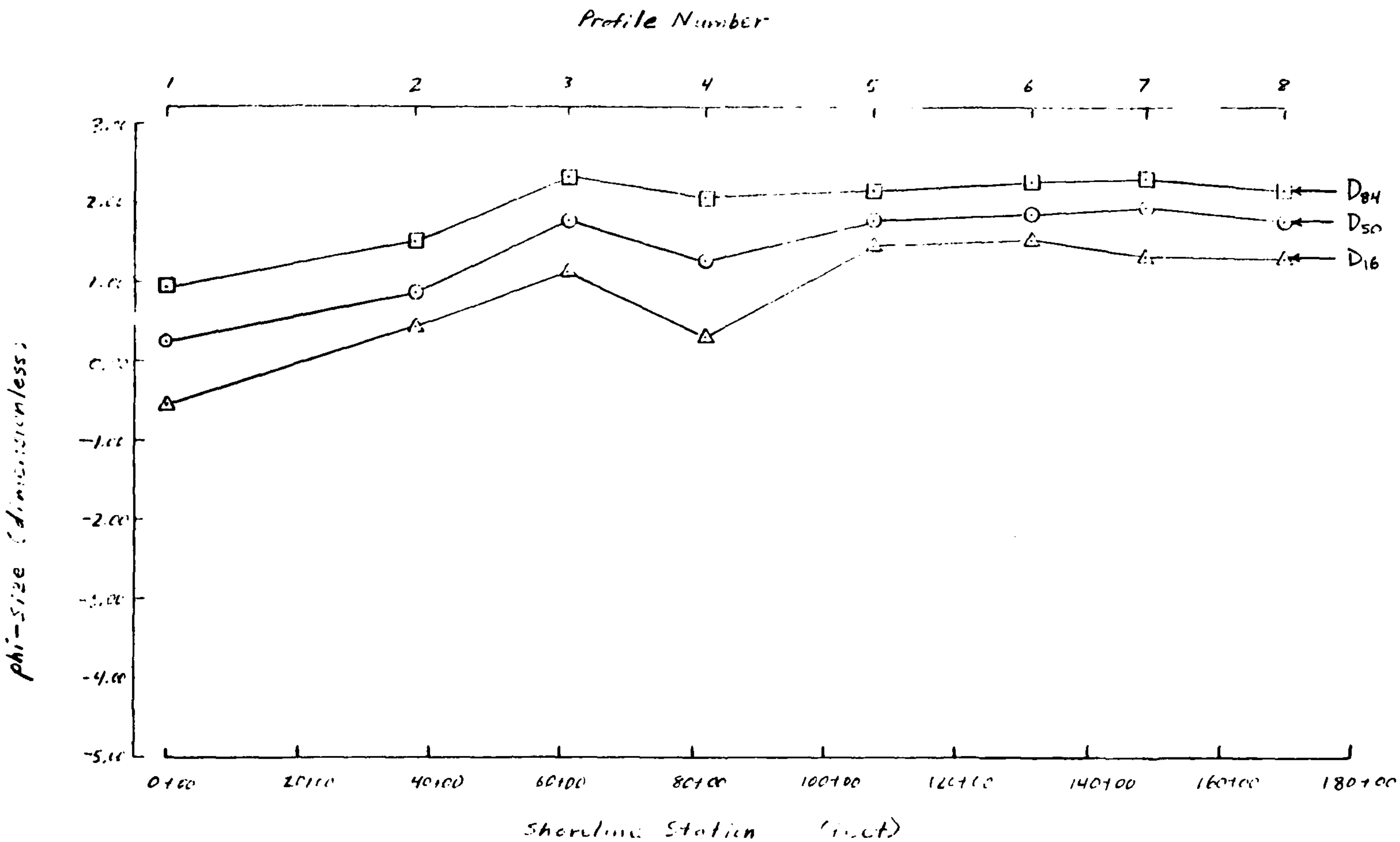

FIGURE A2. BERM SAMPLES AT [illegible] OCEAN VIEW

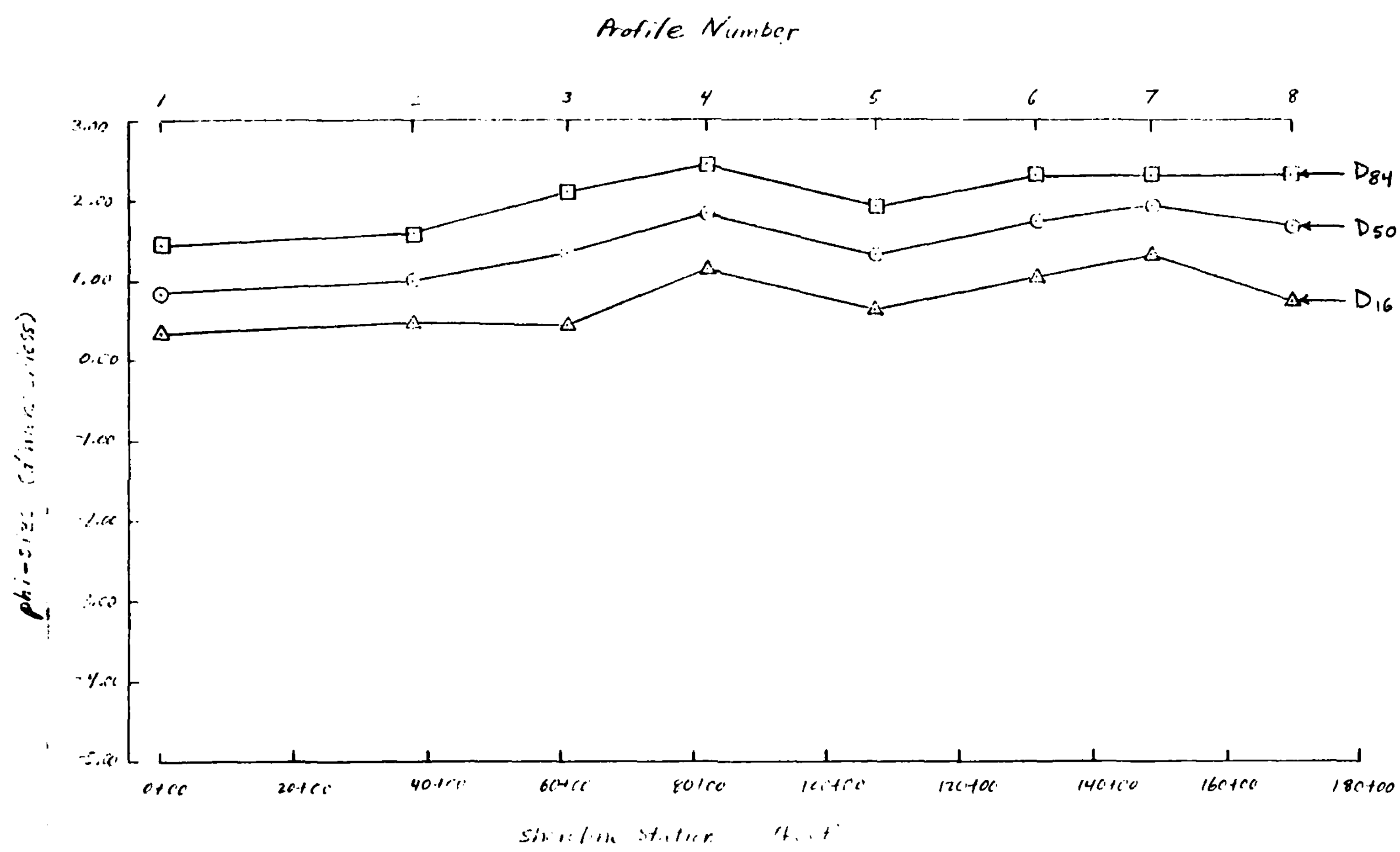

FIGURE A2. FORESHORE SAMPLES AT CAT 1 OCEAN VIEW

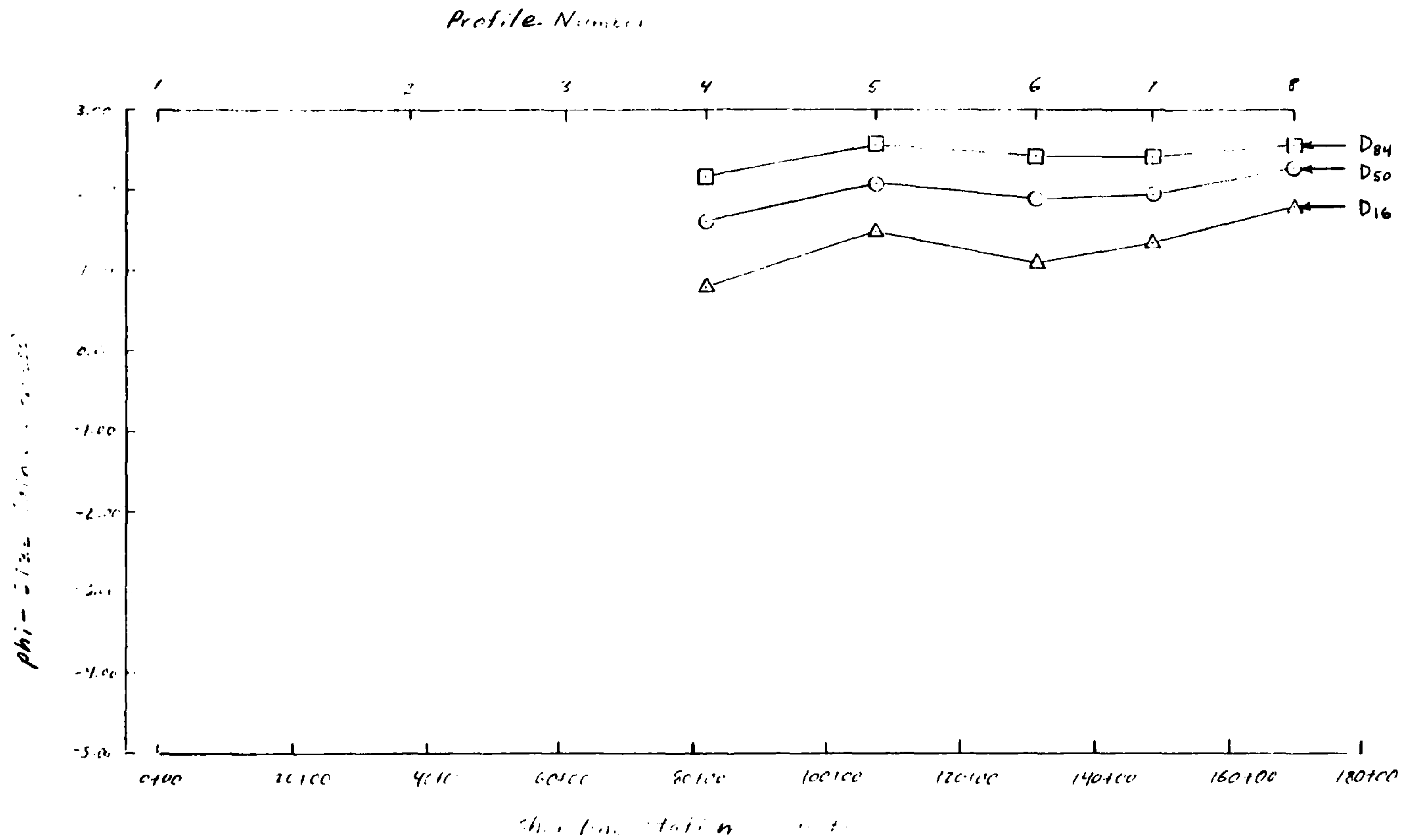

FIGURE A4. LOW-TIDE-TERRACE SAMPLES AT EAST OCEAN VIEW

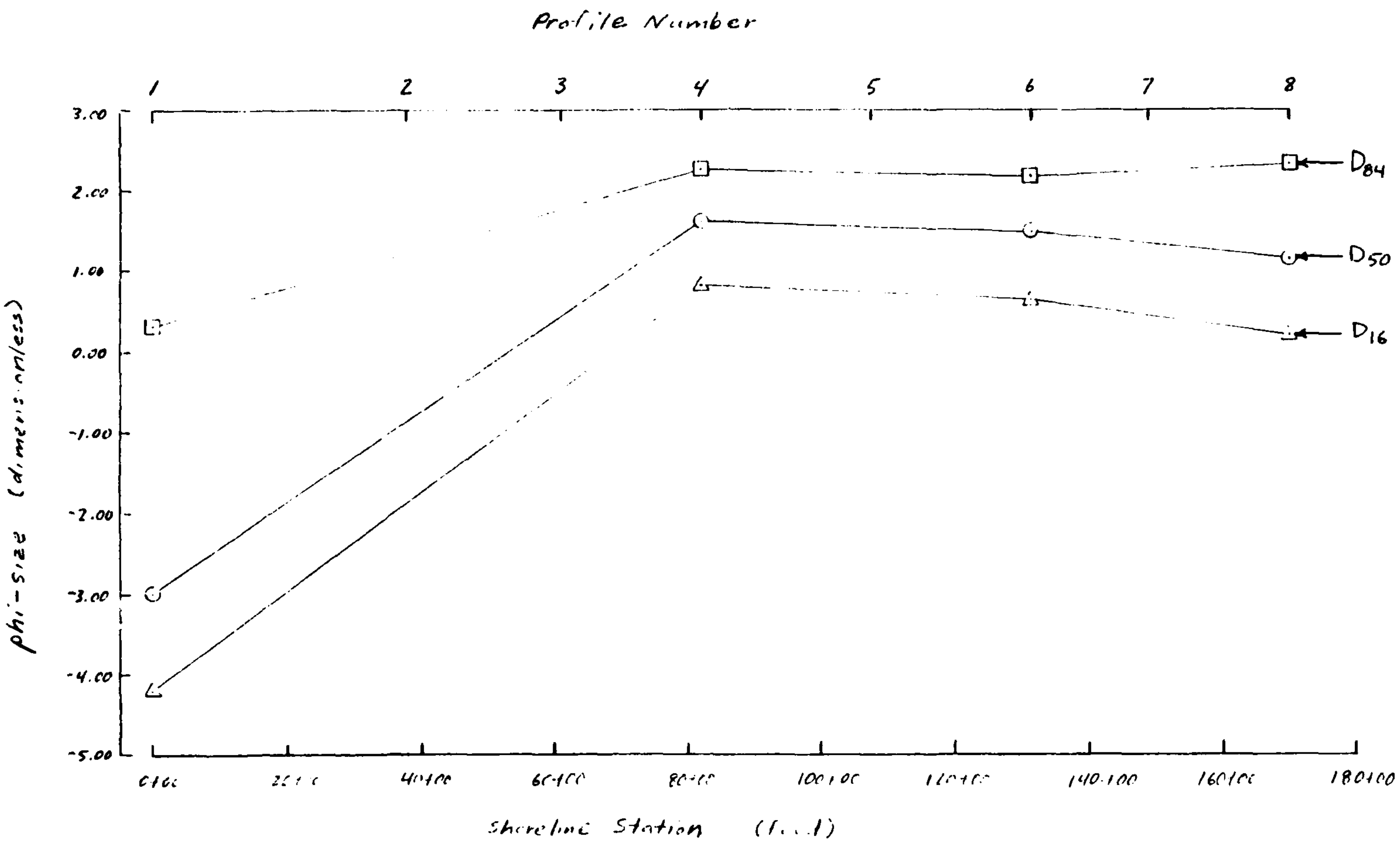

FIGURE A5. OFFSHORE SAMPLES AT EAST OCEAN VIEW

α	$\cos\alpha$	r	X_i	$X_i \cos\alpha$
42	.743	3.0	2.23	1.66
36	.809	3.2	2.59	2.09
30	.866	3.6	3.12	2.70
24	.914	10.1	9.23	8.44
18	.951	8.7	8.27	7.87
12	.978	9.6	9.39	9.18
6	.995	29.2	29.05	28.91
0	1.000	23.4	23.40	23.40
6	.995	26.6	26.47	26.33
12	.978	13.1	12.81	12.53
18	.951	7.3	6.94	6.60
24	.914	6.5	5.94	5.43
30	.866	6.1	5.28	4.57
36	.809	5.6	4.53	3.67
42	.743	4.9	3.64	2.71
$\Sigma =$	13.512			146.09

$$F_{eff} = \frac{\Sigma X_i \cos\alpha}{\Sigma \cos\alpha}$$

$$= \frac{146.09}{13.512} = 10.8 \text{ [illegible]}$$

(at a scale of 1:[illegible]
1 in. = 3.16 statute miles)

$$F_{eff} = 10.81 \times \text{[illegible]}$$

$$= \boxed{34.2 \text{ mi.}}$$

EFFECTIVE FETCH CALCULATION FOR EAST OCEAN VIEW, VIRGINIA

TABLE B2.

END

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